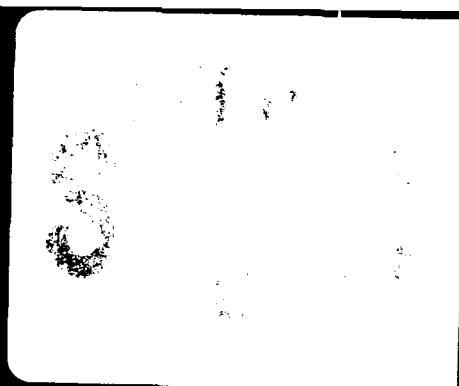


OCTOBER 1992



**SUMMARY  
OF  
RESEARCH**

**1991-1992**

**COMPILED AND EDITED**

**BY**

**PROFESSOR FRED M. FETROW**

**ENGLISH DEPARTMENT**

**TYPESET BY**

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**RESEARCH OFFICE**

**OCTOBER 1992**

**UNITED STATES NAVAL ACADEMY**

**ANNAPOLIS, MARYLAND**

**21402**

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# Foreword

The role of research at the Naval Academy is to maintain an atmosphere of scholarly excellence in which midshipmen seek knowledge. Discipline and curiosity are both essential to a naval officer and the balance of these traits determines the character of our graduates.

In the two decades since the Research Office was created, progress can be measured by the growth in research budgets, papers, books, and presentations. Naval Academy faculty and midshipmen have seized the opportunities to do research provided by local and nearby facilities, research courses, sabbaticals, and travel support.

The information presented in this report describes the research projects and productivity of our faculty and midshipmen for the 1991-1992 academic year. Each of sixteen academic departments in four divisions presents the details of its efforts. The history of the budget and productivity is presented in Figures 1 and 2, showing the growth of research by our faculty.

This growth parallels the increase in civilian faculty Ph.D's to ninety-seven percent. Three research chairs were sponsored by various Naval Commands; the total of three million dollars in research funding included 14% O&M,N funds, 61% Navy, 17% DoD, 6% federal and 2.4% private funds. This distribution reflects minimal institutional support and growing joint services and private funding consistent with national trends. Operating funds included support for fourteen faculty members' efforts in instructional development largely using faculty and midshipmen computers. Our major reimbursable sponsor, after the Chief of Naval Research, is Naval Surface Warfare Center whose \$403,856 supported 26 faculty. The naval laboratories funded a record 50 faculty members' research this year for a total of \$664,401 under the Chief of Naval Research Memorandum of Understanding. Faculty reimbursable funds increased sharply to \$1,971,782 while the total research FY92 budget essentially

**USNA RESEARCH BUDGET**  
Thousands of Dollars

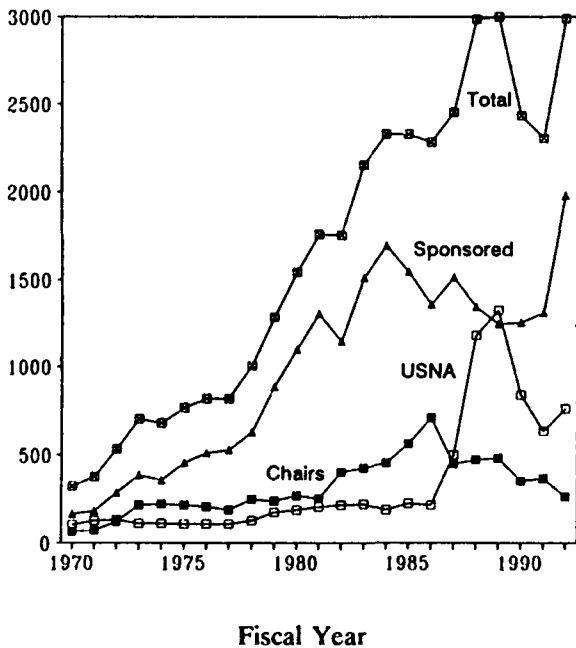


Figure 1. The growth of the research budget since 1970 reflects contributions from programs such as sponsored projects of individual faculty, research chairs, and Academy-wide programs.

**RESEARCH PRODUCTIVITY**  
Number Reported

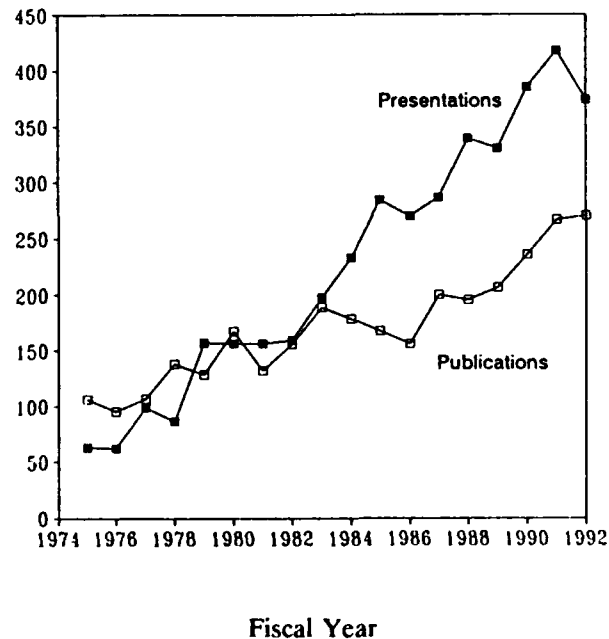


Figure 2. The productivity of faculty and midshipmen measured through publications and presentations, has generally increased with the research budget.

## FOREWORD

equalled the past record of three million dollars. The faculty are moving toward active, externally sponsored research.

Midshipmen participation in research at the Naval Academy continues with eighty-three research courses and fifty-two design courses reported, thirteen Trident Scholars (with eleven selected for the coming year), some 50 midshipmen using summer leave time to work with a dozen Navy, DoD, and Federal Agencies, and 112 travelling abroad under the Cox foreign language program.

Agreements of research collaboration and support were added this year with the Naval Surface Warfare Center, Panama City, Florida, in coastal systems engineering and the National Cryptological School of the National Security Agency in language instruction. The visiting faculty program this year included twenty participants, including research chairholders, Navy laboratory staff, two Office of Naval Technology Postdoctoral fellows, and individuals choosing to join our faculty for a period of research. Their active involvement with our

faculty and midshipmen maintains a dialogue essential to our national participation.

Faculty research continues to be recognized nationally. Language Studies faculty won the 1991 EDUCOM national award for best curriculum innovation in humanities for its Interactive Video Project of language instruction. Midshipman 1/C Susan S. Minton won first place in the American Meteorological Society's Father James B. Macelwane award for the outstanding undergraduate research paper in the atmospheric sciences. Midshipman Minton was a Trident Scholar with Associate Professor David Smith on a project entitled "Causitive Mechanisms for Explosive Cyclone Development over the Atlantic." Midshipman 1/C George B. Rowell IV won second prize for the best paper at the Mideast Regional Phi Alpha Theta Conference in April. Research at the Naval Academy has achieved increasing recognition, and its benefits to our teaching mission are proportional.



ROBERT H. SHAPIRO  
Academic Dean and Provost



CARL S. SCHNEIDER  
Director of Research





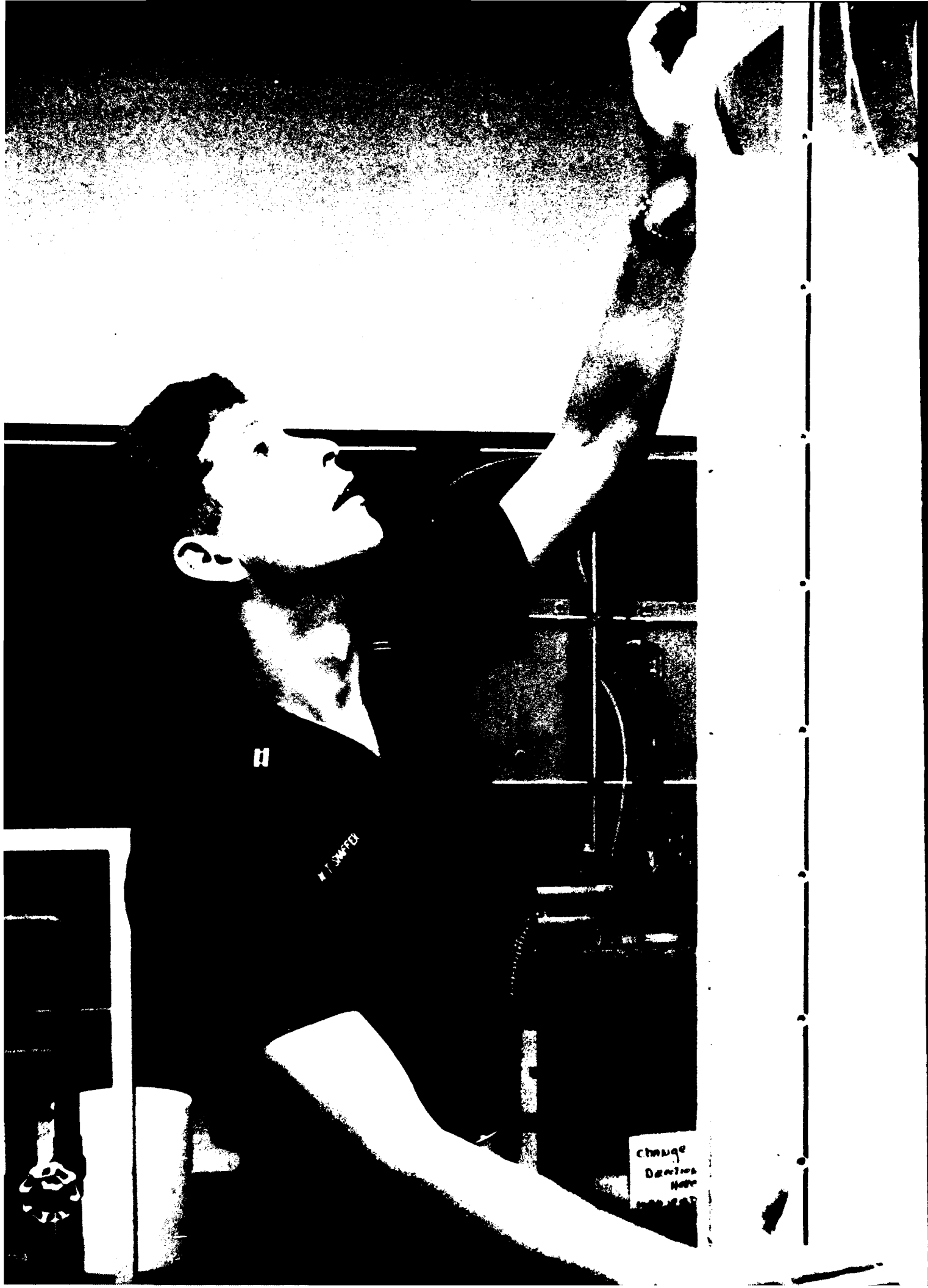
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## Division of Engineering and Weapons





# Aerospace Engineering

Professor Maido Saarlus  
Chair

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**F**aculty and midshipmen research in the Aerospace Engineering Department covers many of the areas of specialization in aerospace engineering. These studies range from unmanned low-speed aircraft (RPV) to communication problems with space shuttles.

Research is supported mainly through funds from government agencies such as the National Air and Space Administration, the Naval Research Laboratory, and the Naval Space Command. The Naval Academy Research Council has provided generous support for the faculty research efforts during the summer intersessional. This sponsored research provides benefit to its various sponsors and keeps the faculty current in the state-of-the-art engineering practice. In addition, faculty participation in current development and research in the field of aerospace engineering has enhanced the learning process in the classroom, from the most fundamental courses to the final capstone design course.



## Sponsored Research

### Unmanned Vehicle Studies

Researcher: Professor Bernard H. Carson  
Sponsor: Naval Research Laboratory, Code 5712

This is a continuing study involving basic feasibility studies and theoretical development in support of

the Navy's unmanned vehicle program in concert with the Naval Research Laboratory.

### Coaxial Propeller/Rotor Interaction Investigation

Researcher: Associate Professor Gerald F. Hall  
Sponsor: National Aeronautics and Space Administration/Ames Research Center

This research seeks to develop a computer code capable of analyzing axial inflow performance for the evaluation of the merits of the prop-fan/tilt rotor propulsion system. This code, utilizing unsteady vortex lattice techniques, will analyze the system in hover and will also provide high speed, initially subcritical, prop-fan cruise information.

An experimental investigation, utilizing the rotor hover stand at the U.S. Naval Academy, of the

prop-fan/tilt rotor system will be carried out. The full scale hover stand will provide thrust and power data as a function of vertical spacing between the rotor and prop-fan configurations, differential rotation of the two components, and power ratio.

Based on the results of the analytical and experimental methods, recommendations and a plan for the development of the prop-fan/tilt rotor propulsion system will be prepared.

### Divergence of Composite Wing Structures Incorporating Non-Classical Effects

Researcher: Assistant Professor Gabriel N. Karpouzian  
Sponsor: Naval Academy Research Council (ONR)

This research project was concerned with the study of static aeroelastic instability (divergence) and load distribution of aircraft composite cantilevered wing structures whose structural model include non-classical effects such as those of transverse shear deformation and warping restraint.

The specific objectives of the investigation were: (1) formulation of the equations governing the motion of cantilevered anisotropic composite swept wings incorporating both transverse shear deformability and warping restraint effects; (2) solutions of the governing equations in the subcritical flight regime for a uniform swept cantilevered wing under a quasi-steady two-dimensional aerodynamic load; and (3) comparison of the results with those obtained by the classical theory to put in evidence the non-classical effects incorporated in the study.

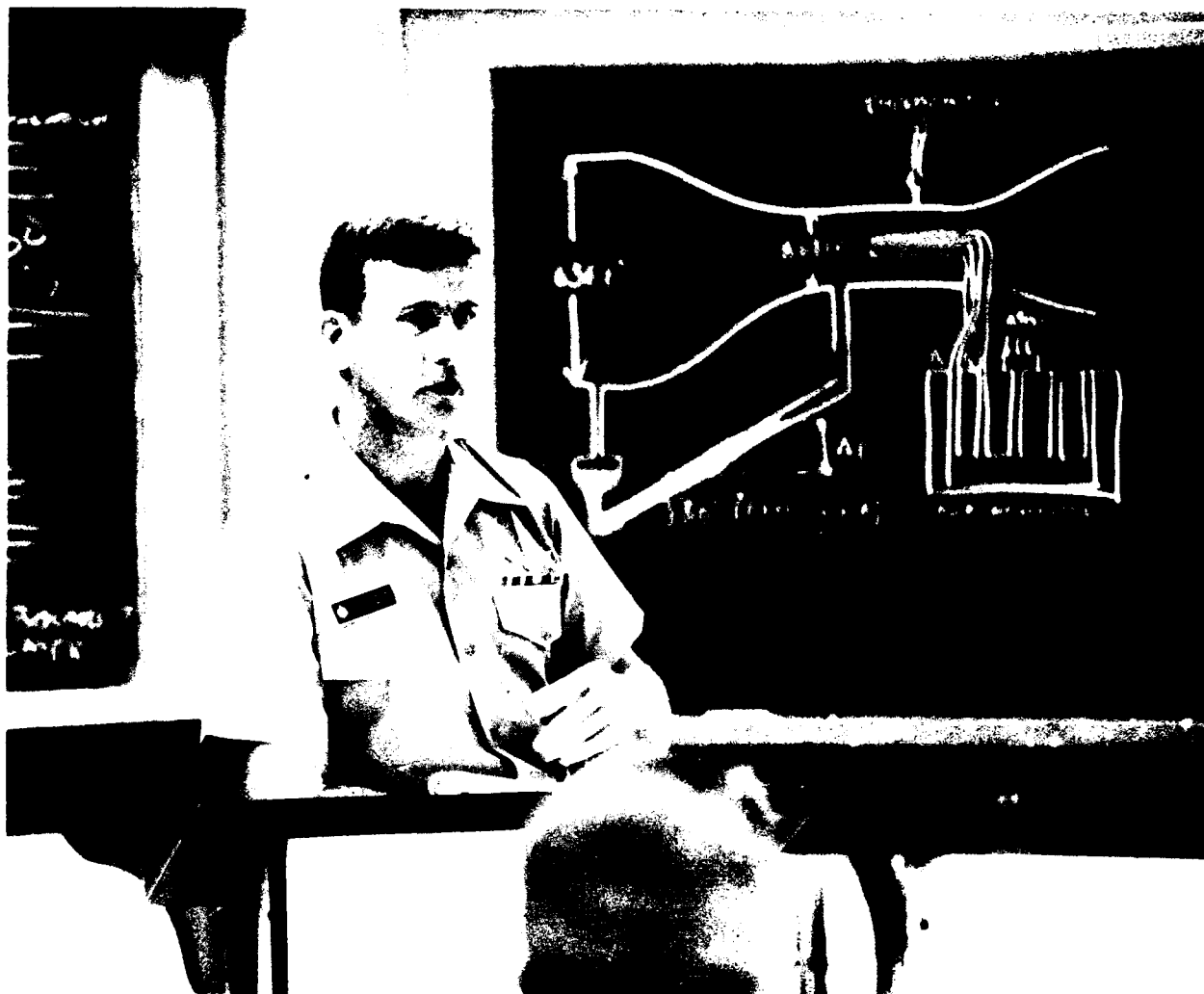
Using Hamilton's variational principle, the

governing equations of motion and their associate boundary conditions have been obtained. An exact method based on an integral transform technique is employed to solve the system of equations. The solution to the divergence problem and the static load distribution of a transversely isotropic wing structure is obtained for a set of values of the stiffness parameter  $E/G'$ . It is found that the divergence speed of a composite swept-forward wing based on classical theory  $E/G'$  to zero is an overestimate of the actual critical speed of the wing with a finite non-zero  $E/G'$ . Therefore, the design of composite swept-forward wings on the basis of neglecting the effect of transverse shear deformation would lead to a structural failure for a speed range beyond the actual divergence speed. The results for the spanwise aerodynamic load distribution are also obtained for a range of values of  $E/G'$  in the subcritical flight regime. They show indeed that the

effect of transverse shear deformation is dramatic in comparison with the classical results.

A comparison between cases with and without warping restraint effects remains to be made. Also, choosing a more complex material other than the

transversely isotropic material from the stiffness standpoint would allow for the implementation of tailoring techniques to alleviate the detrimental effects of transverse shear deformation.



## **Independent Research**

### **Navy/Marine Corps Low Earth Orbit Satellite Communications**

Researchers: Assistant Professor Walter K. Daniel and  
Commander Robert E. Bruninga, USN (Ret)

The project used seven small communications satellites that were launched as part of a Defense Advanced Research Project Agency (DARPA) program. The goal of the DARPA program was to research new applications for low Earth orbit UHF military satellite communications; this project concentrated on Navy and Marine Corps applications. The first successful demonstration

involved a data beacon onboard vessels that relayed position and status reports automatically via satellite. Voice communications between ships at sea and land sites were accomplished using existing radios. A satellite-to-satellite relay was demonstrated using the DARPA satellites and the Navy Fleet Satellite (FLTSAT) spacecraft.

### **Structural Analysis of the AMSAT Phase 3D Communications Satellite**

Researcher: Assistant Professor Walter K. Daniel

The Radio Amateur Satellite Corporation (AMSAT) is currently designing a next-generation high-altitude communications satellite (Phase 3D, or simply P3D) to be launched in 1995. The satellite will be launched on the new Ariane 5 launch vehicle. Two scientific spacecraft will be attached to the top of P3D during launch, so the structural

design of the satellite is unique and challenging. Finite element analysis of the P3D structure showed that natural frequencies were low enough to couple with the launch vehicle frequencies. Alternative materials and design concepts were explored using the finite element model.

### **Hull-Superstructure Interaction**

Researcher: Assistant Professor Michael D. A. Mackney

The principal aim of this doctoral study is to investigate the fundamental behavior of hull-superstructure interaction. The work is essentially numerical and experimental in nature. The numerical work uses the finite element method and three purpose written pre-processors necessary to generate error free data sets representing simplified hull-superstructure models. Hundreds of data sets for different geometrical arrangements are being generated from the interactive preprocessor, written

in True Basic.

The experimental program of work is based on six scaled acrylic models which are strain gauged and statically loaded to simulate hull bending and torsion. Some numerical work is being done modeling hull damage.

The work is continuing with both the numerical and experimental studies, but with a reduced number of numerical case studies.

# Research Course Project

## Low Cost Remotely-Piloted Vehicle

Researchers: Midshipmen 1/C Jeffrey A. Craig  
and Mark A. Smith, USN  
Adviser: Professor Bernard H. Carson

This was an EA496 Research Project conducted by Midshipmen Craig and Smith to study and design a

low cost, expendable remotely-piloted vehicle for low altitude aerial surveillance.

## Marine Corps Tactical Satellite Communications

Researcher: Midshipman 1/C Gavino Rivas, USN  
Adviser: Assistant Professor Walter K. Daniel

Satellite communications could serve Marine Corps tactical users as an alternative to High Frequency (HF) radios that can be readily located. Although analysis showed that most satellite passes were low in the sky, further analysis proved that the satellites transmitted enough power for communications to be feasible. Testing showed that either a standard military satellite antenna or an experimental ver-

sion would provide acceptable performance. Small groups were deployed at the Quantico Marine Corps Base to test the equipment in a field exercise. Communications between the groups in the field and the Naval Academy were maintained for the duration of the exercise. Other monitoring stations as far away as Minnesota reported clear and strong signals.

## MSX Simulation

Researcher: Midshipman 1/C William J. Palermo, USN  
Adviser: Visiting Professor James G. Severns

The Midcourse Space Experiment (MSX) Satellite currently under construction at Applied Physics Laboratory (APL) uses high-speed reaction wheels to orient the entire 6000-kilograms spacecraft for pointing the large infrared telescope, various visual imagers and radar receivers which are all oriented toward the same spacecraft axis. The MSX Simulator Group is responsible for the simulation of the entire MSX environment for ground testing of its flight systems and software before launch. They simulate the space environmental effects on the satellite, the launch and orbit scenarios, the mission procedures, and all onboard sensors and control systems. One of their largest tasks is to model the target trajectories and response of the attitude control system and reaction wheels.

The work of this research project was a collab-

oration with the MSX Simulator Group. There were three areas of study involved. The first was a model to trace the path of Earth-orbiting bodies forward or backward through time. The second area was a study of the Sun's exact position in the Earth-centered inertial reference frame based upon a reference position at Julian date 2000. This model was combined with the orbit integrator to find shadow times and the Sun's relative position vector for satellites. The third effort involved assessment of the precision of interpolators of possible target trajectories for the MSX satellite. The first two parts of this effort were completed prior to 1 May 1992. The work of the third area is a continuing effort at APL.

This research was supported by the Johns Hopkins University Applied Physics Laboratory.



## Applications of Fiber Optics in Space

Researcher: Midshipman 1/C Richard L. Whipple, Jr., USN  
Adviser: Visiting Professor James G. Severns

At present fiber optic systems are primarily used for communication purposes, such as by telephone companies or cable television suppliers. The optical technology does appear to have a future in space related applications, however. Some uses already being practiced or tested include relaying data between ground stations and antenna, and antenna testing. Future applications could certainly include uses on actual spacecraft for communication between systems.

Two projects dealing with fiber optics have been undertaken since the start of the semester. The

first task involved determining the frequency fluctuation across a wide band showing a continuous (rather than discrete) spectrum. This random noise shows up in sidebands which can pose significant difficulties in systems such as Doppler radar or multichannel communication receivers where there are narrow bandwidths.

Both of the tasks were successfully completed during the spring semester, though the study of phase noise is an ongoing effort at Johns Hopkins University Applied Physics Laboratory.

## Estimation of Atmospheric Drag

Researcher: Midshipman 1/C Fernando J. Argeles, USN  
Adviser: Visiting Professor James G. Severns

This project was conducted in two phases. The purpose of phase I was to determine whether orbital decay due to atmospheric drag could be measured using doppler data. Due to difficulties during launch, the defense microsats were placed in 220 N Mi circular polar orbits (inclination =  $82^\circ$ ) instead of the 400 N Mi planned altitude. In this lower orbit the effects of atmospheric drag were pronounced. Using the doppler shift of the spacecraft downlink RF carrier, the time of closest approach of the satellite to the Naval Academy tracking antenna could be recorded. By measuring the elapsed time between consecutive passes and dividing by the number of orbits completed, the orbital period could be estimated. Changes in the orbital period

are directly related to decay due to atmospheric drag. This simple method worked quite well for the satellites of interest.

Phase II of the project requires use of the formal mathematical method of differential correction of parameters to improve estimates of the orbit elements. This is done in such a way that orbit decay is treated as an orbital element. Improved orbits are then calculated to "best fit" observations made of the actual orbit, in this case, doppler data. The computer program to handle the data in this way has been written, but, as yet, no data have been analyzed. This project is expected to be completed by 30 August of this year.

## Publications

KARPOUZIAN, Gabriel N., Assistant Professor, co-author, "The Optimal Power Performance of an Endo-Reversible Combined Cycle," *Journal of the Institute of Energy* (March 1992), 41-45.

An optimal-performance analysis of an endo-reversible combined cycle (two single endo-reversible cycles in a cascade) was carried out, and the maximum power and the efficiency at maximum power for steady-state operation were obtained. These two performance factors, measured against those of a single cycle, can be expressed in terms of two design parameters, and the consequences of varying one parameter were examined in detail. It was shown that as regards efficiency the combined cycle is superior to the single cycle for all values of that design parameter; and as regards power output, only beyond a certain value of that parameter is the combined cycle superior to the single cycle.

KARPOUZIAN, Gabriel N., Assistant Professor, co-author, "The Equations Governing the Motion of Wing-Aileron Structural Systems Constructed from Advanced Anisotropic Composite Materials," *American Institute of Aeronautics and Astronautics Paper 92-2469*, April 1992.

The lateral control and maneuverability of aircraft wings constitute important design requirements for airplanes. Their characteristics may be affected to a significant extent by aeroelastic effects, particularly at high dynamic pressures, and in the case of thin wings, swept wings, etc. Wing flexibility may result in a serious loss of the lateral control power, in the total loss of the control effectiveness, and even in the reversal of the rolling control. Due to their evident negative implications, the prevention of occurrence of these aeroelastic effects must always be taken into account in the design process of a wing.

For standard metallic wings, this problem was studied in a number of earlier works and already constitutes a classical topic. However, with the in-

creased use in the design of aircraft structures and especially of the next generation of aerospace vehicles, of composite material systems, a reconsideration of the aileron control problem in this broadened framework is needed.

The reconsideration of this problem has as basic goals: (1) a better understanding of the implications of some important effects either ignored and/or of the ones which are peculiar for composite structures; and (2) the use of these effects which could play a beneficial role on the aileron control.

MACKNEY, Michael D.A., Assistant Professor, "The Aeronautics and Astronautics Curricula at the United States Naval Academy," *Proceedings of Aerotech '92 Aerospace and Airport Technology Congress, Education and Training in the Armed Forces*, Paper C428/22/06S, January 1992.

The Aerospace Engineering Department of the U.S. Naval Academy offers one of the most stimulating and demanding academic programs preparing naval officers who will serve in the forefront of the inception, development, and deployment of naval air and space resources.

Over 100 midshipmen enroll each year in the four-year fully-accredited curriculum, which provides a foundation in engineering fundamentals through courses in chemistry, physics, mathematics, engineering mechanics, thermodynamics, and electrical engineering. Students then undertake aerospace engineering studies, including aerodynamics, propulsion, and structures within either an aeronautics or astronautics specialization. The astronautics track includes astrodynamics, satellite attitude dynamics and control, and space environment. Both specializations use some of the most extensive and advanced laboratory facilities in the country, and conclude with electives and a major design course.

The paper describes the curricula, facilities, and educational aims of the Aerospace Engineering major of the U.S. Naval Academy.

## Presentations

DANIEL, Walter K., Assistant Professor, and Robert E. BRUNINGA, Commander, USN (Ret), "Uses of Amateur Satellites in Engineering Courses," AMSAT Annual Meeting and Space Symposium, Los Angeles, California, 7 November 1991.

KARPOUZIAN, Gabriel N., Assistant Professor, co-author, "Aeroelastic Stability Analysis of Anisotropic Composite Wings Based on a Refined Structural Model," International Conference on Industrial and Applied Mathematics, Washington, DC, 3-12 July 1991.

KARPOUZIAN, Gabriel N., Assistant Professor, co-author, "The Equations Governing the Motion of Wing-Aileron Structural Systems Constructed from Advanced Anisotropic Composite Materials," Thirty-third Structures, Structural Dynamics, and Materials Conference, Dallas, Texas 13-15 April 1992.

MACKNEY, Michael D.A., Assistant Professor, "The Aeronautics and Astronautics Curricula at the United States Naval Academy," Seminar 22 Education and Training in the Armed Services, Aerotech '92 Aerospace and Airport Technology Congress, Birmingham, England, 15 January 1992.

ROGERS, David F., Professor, "Dynamic Rational and Nonrational B-spline Surfaces for Display and Manipulation," Simon Fraser University, Vancouver, British Columbia, 8 June 1991.

ROGERS, David F., Professor, "Dynamic Rational and Nonrational B-spline Surfaces for Display and Manipulation," Boeing Commercial Airplane, Seattle, Washington, 12 June 1991.

ROGERS, David F., Professor, "Dynamic Rational and Nonrational B-spline Surfaces for Display and Manipulation," Microsoft Corporation, Seattle, Washington, 16 June 1991.



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## Satellite Earth Station Facility

Robert E. Bruninga  
Director

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**T**his year the Satellite Earth Station was involved in over 27 student and faculty projects. Highlights were communications experiments with the Space Shuttle, Soviet Space station Mir, FLTSATS, DARPA Microsats, moonbounce, Transit navigation satellites, ORBCOMM-X and AMSTAT OSCARS 13 and 17.

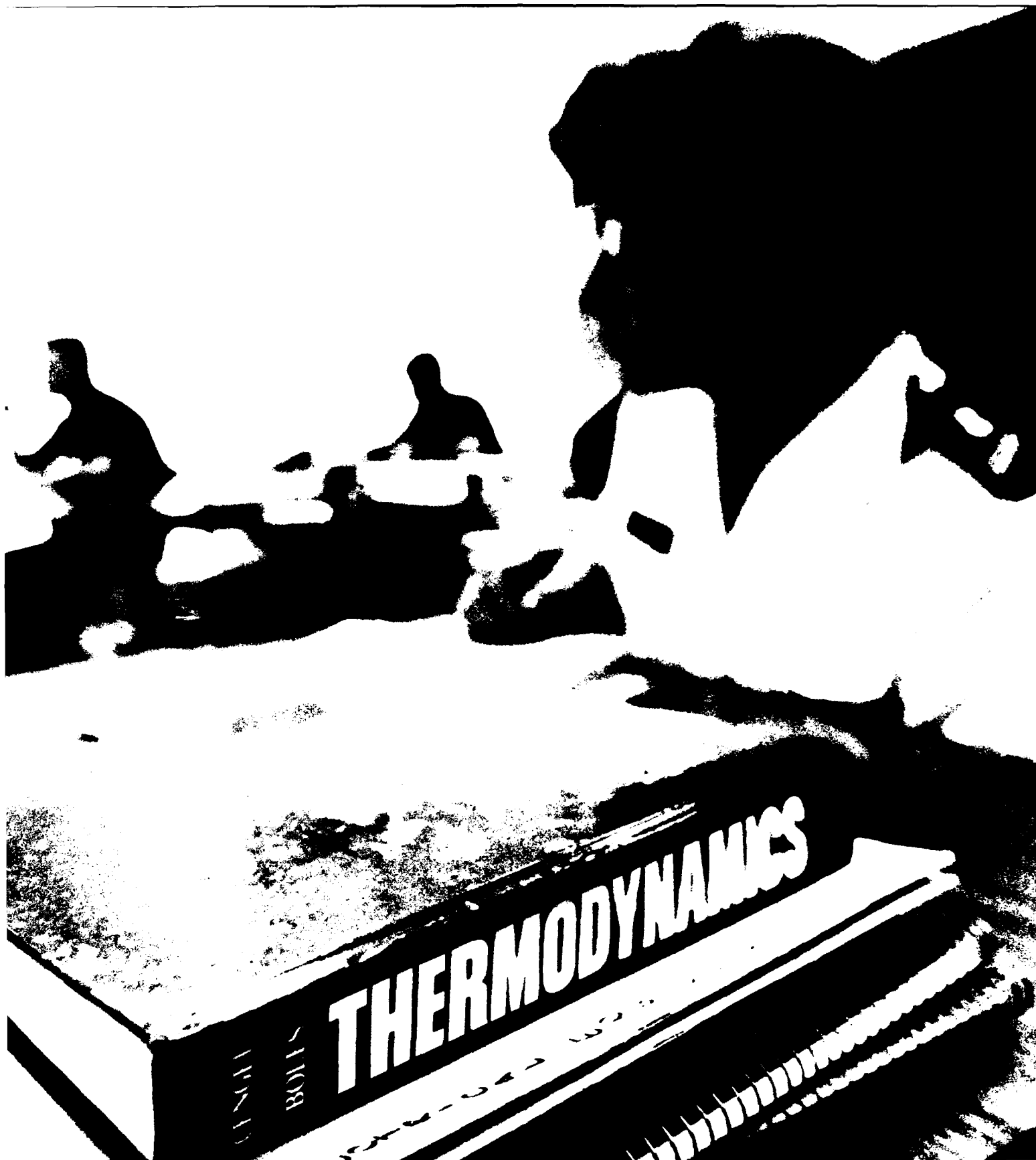
Almost 100 students and faculty participated in tracking the Space Shuttle during mission STS-45 and were rewarded with a successful two-way contact on 27 March 1992. Similar communications were successful with Cosmonauts onboard MIR in September 1991 and early April 1992. The Naval Academy conducted experiments on over 160 orbits of the DARPA experimental Microsats before they de-orbited in January 1992. The dish was used in an attempted satellite recovery mission for ORBCOMM-X, and an optical tracking capability was added to the restored high gain tracking camera.

Student laboratory sessions were conducted in satellite tracking and communication link calculations. Orbital elements for almost 200 satellites were maintained for the student tracking programs, and a receive capability was maintained for at least 36 of those spacecraft for use in these sessions. Data and telemetry receivers for OSCAR-17 and MIR were interfaced to the Naval Academy Data Network for student access throughout the Academy.

Hundreds of hours of foreign language TV reception were provided, and experiments were conducted with the Electromagnetic Compatibility Analysis Center to quantify radar interference susceptibility levels to satellite TV reception. The



Yard Patrol Craft SATCOM system performed well during summer deployments, handling over 400 messages and position reports during the midshipmen summer cruises of 1991. The experimental system has been extended to eight YP's for the summer of 1992.



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# Electrical Engineering

Professor Richard L. Martin  
Chair

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**R**esearch and scholarly activity are fundamental to the vitality and viability of a discipline. This is particularly applicable to electrical engineering, which is broadly based and rapidly expanding. Research helps both faculty and midshipmen keep abreast of advancing technology and ultimately improves the effectiveness of the academic environment by encouraging a modern and relevant curriculum.

Funding for our research comes from the Naval Research Laboratory, the Naval Surface Warfare Center, the Defense Nuclear Agency, and from within the Naval Academy. Research topics supported during the past year included Electronic Warfare Scenario Modeling for Expert Real-Time Decision Aids, the Heuristic Adaptive Reasoning Project - Phase Two, The Effectiveness of Electronic Countermeasures, Simulation of Low Dose-Rate Ionizing Radiation Testing of Microelectronics, and Characterization of Optical Fiber Sensors: Interferometric Measurements of Linewidth and Phase Noise of an Er-doped Fiber Ring Laser. This faculty research contributes directly to our operating forces and provides relevant topics which benefit the professional as well as the academic development of our midshipmen.



## **Sponsored Research**

### **The Heuristic Adaptive Reasoning Project - Phase Two**

Researcher: Assistant Professor Glen C. Collins  
Sponsor: Naval Academy Research Council (ONR)

The Heuristic Adaptive Reasoning Project represents a deliberate combination of numerical and symbolic inference techniques wherein numerical techniques are used solely for representing and tracking degrees of belief, while symbolic techniques are used for overall control and decision selection purposes. Objectives have been to create a diagnostic system framework which, from a domain expert's point of view, would be perceived as logical, reasonable, and understandable, and to permit direct use by domain experts by maximizing their ability to use familiar concepts and terms without requiring them to learn new syntax.

Phase two research on the Heuristic Adaptive Reasoning Project sought to produce the specifica-

tions for a fully functional diagnostic decision system which is applicable across multiple domains of interest and which facilitates easy decision system construction by domain experts. It is a logical extension of the proof-of-principle system developed during phase one, and will determine the extent to which the 'Reasoner' promises to be genuinely usable as an on-line diagnostic tool. Phase two further seeks to extend the proof-of-principle system developed in phase one by incorporating needed characteristics, one by one, and testing their effectiveness in actual on-line applications. Required characteristics include the accommodation of evidential groupings, sensitivity to hierarchical relationships among hypotheses, and the detection of conflicting data.

### **Simulation of Low Dose-Rate Ionizing Radiation Testing of Microelectronics**

Researcher: Professor Richard L. Martin  
Sponsor: Naval Research Laboratory (Code 6810) and Defense Nuclear Agency

A coordinated set of experiments was initiated during the previous academic year and extended into the present year. That set of experiments consisted of large single dose gamma ray irradiations (impulses) to hardened CMOS devices, followed by high temperature annealing, a series of small impulses each followed by room temperature

or high temperature annealing, and an equivalent low dose-rate experiment. In addition to completion of the low dose-rate experiment and data analysis of all of the other experiments, the set of experiments was repeated for a batch of commercial non-hardened CMOS devices.

### **The Effectiveness of Electronic Countermeasures**

Researcher: Assistant Professor Don Y. Northam  
Sponsor: Naval Research Laboratory, Code 5720

Two problems were investigated. The researcher first assisted Dr. N. Barkakati in gathering background information for the study of sensor integration for shipboard radar and EQ systems. This effort was performed as preparation for a new 6.2 ENEWS project that was approved for a FY92 start. Deliverables were memoranda and briefings presented to Dr. Barkakati. Second, a reexamination of the model of over-water multipath effects (on radar signals) developed ten years earlier

was begun. This model is still in use in the Naval Research Laboratory EW simulators. Although effects other than those addressed by the model have become important to EW performance studies, the model has not been extended beyond the earlier work. The researcher examined the possibility of conducting new experiments to provide a basis for extending the model, but funding limitations precluded the writing of proposals for such work.

### Characterization of Optical Fiber Sensors, Interferometric Measurements of Linewidth, and Phase Noise of an Er-doped Fiber Ring Laser

Researcher: Assistant Professor R. Stephen Weis  
Sponsor: Naval Research Laboratory, Code 6570

There is considerable interest in the development and application of doped fiber amplifiers and lasers in communications systems. The use of such devices in fiber optic sensor systems is also of interest (e.g., broadband superfluorescent Nd and Er fiber sources for fiber gyroscopes). Single frequency fiber lasers are potentially useful sources for interferometric sensor applications. A number of single frequency fiber lasers have been demonstrated, most commonly utilizing a traveling-wave ring configuration. The important laser characteristics for interferometric sensor systems are

phase, noise, linewidth, frequency stability, and tunability. The researcher reports measurements of the linewidth and low-frequency phase noise of an Er-doped fiber ring laser with an intra-ring fiber birefringent spectral filter. Measurements of the low-frequency laser jitter ( $1/f$  FM noise) are reported for the first time. Research also demonstrates that linewidths measured using the delayed self-heterodyne method are significantly broadened by laser FM noise due to acoustical perturbations of the laser and the delay fiber in the interferometer.





## Independent Research

### Electronic Warfare Scenario Modeling for Expert Real-Time Decision Aids

Researcher: Assistant Professor Glen C. Collins

Current military command and control (C2) or electronic warfare (EW) systems provide no capability for scheduling the platform's hardkill and softkill assets in an integrated manner. Where multiple threats must be dealt with for prolonged periods of time, tactics which maximally and optimally utilize the platform's assets will prove invaluable. Human decision makers, however, may become overloaded under excessively stressful conditions, reducing their ability to respond optimally within the imposed time constraints. These limitations point to the need for high-speed decision aids or decision automation tools. Two models were developed in this research work to guide the construction of these decision aids. One model represents a generalized engagement incorporating  $m$  threats and  $n$  assets; this model consists of a collection of dynamic tracks and two databases, one for threat and asset description, and one for knowledge of tactics and doctrine.

The second model provides a pattern for the decision-making process itself, involving the genera-

tion and evaluation of asset deployment schedules and, possibly, an AI component for final schedule selection. This model sought to (1) characterize the combat decision process in order to partition the problem space into algorithmic and knowledge-based sectors, and (2) develop a comprehensive design for the architecture of the decision support system based upon the results of the decision process analysis. Overall, the decision process model is composed of five iterative steps: (1) assess current status, (2) collect/compute action options, (3) generate and evaluate combined action schedules, (4) weigh alternatives and optimize, and (5) select an action schedule and implement it. This decision process must be real-time and dynamic, since actions taken early on will affect the state of the engagement as it develops, thereby introducing the need for ongoing changes and corrections.

The Naval Research Laboratory helped support this research effort.

## Research Course Projects

### Investigation of Fiber Optic Liquid Level Sensors

Researcher: Midshipman 1/C Carlos D. Flores, USN

Adviser: Assistant Professor R. Stephen Weis

The researcher fabricated a liquid level sensor that was based on evanescent field interaction with the liquid by polishing the side of a multimode fiber. It was determined that the sensor was impractical for use in Navy fuel tanks. During the second semester, a pressure sensor was built that can be

used to measure hydrostatic pressure and hence liquid level height. The researcher designed and fabricated both the optical system and the processing electronics. The output is an analog signal that is calibrated to read liquid-level height directly.

### Micro-Computer-Controlled Model Railroad System

Researcher: Midshipman 1/C Michael M. Hocker, USN

Adviser: Professor Stephen H. Burns

The goal was to interface a micro-computer with a model railroad. The computer was to be able to control all the operations of the railroad. The system was to be composed of five major components: the micro-computer, the micro-computer interface, the on-board train controllers, the accessories bus, and the device terminals. Two

components have been completed: the on-board controller and the micro-computer interface. The micro-computer software is also partially developed. The remainder of this report explains each of the completed circuits in detail and delivers an overview of how the circuits fit in to the overall operation of the COMR.

### Motor Current Analysis for the Diagnosis of an Air Compressor

Researcher: Midshipman 1/C Michael A. Tinston, USN

Adviser: Professor Antal A. Sarkady

Signal features of current derived variables found in a three-phase induction motor are compared under two different mechanical load conditions. The mechanical load attached to the motor is a four-stage high-pressure compressor used on submarines. The load conditions are either (a) baseline: no known defects in the compressor; or (b) defect: with a defective valve installed in the compressor. The signal processing techniques used on the current and power signals generated by the three-

phase motor are discussed in detail. Digital computations are performed with a Hewlett-Packard 9000/330 computer. They include the use of a fast Fourier transform, a peak envelope detector, and a spectral averaging routine. Envelope analysis indicates that there are some differences between the baseline data and the defect data. This difference is found in the spectrum of the envelope of the reactive power,  $Q$ ; as well as in the spectrum of the envelope of the sum of currents squared data.

## Publications

BUTKA, Brian K., Assistant Professor, "A Model of Narrow-Bandgap Semiconductor Misfets," *Proceedings of the Twenty-second Modeling and Simulation Conference*, 22 (May 1991), 2449-2456.

The metal insulator semiconductor field effect transistor (MISFET) is the primary active device in narrow-bandgap semiconductors. Although circuit applications of MISFETS in these materials are currently under development, existing models in the literature do not reflect the unique physics of MISFETS fabricated in these materials. This paper develops a new model of narrow-bandgap MISFETS which incorporates narrow-bandgap semiconductor physics such as carrier degeneracy, Fermi-Dirac statistics, and the carrier concentration dependence of the material bandgap. The developed model is demonstrated to accurately model previously published experimental data and is substantially more accurate than existing models for very narrow-bandgap material. The strengths and weaknesses of this new model are discussed, and suggestions for future improvements are made.

BUTKA, Brian K., Assistant Professor, co-author, "DTRC Matrix Converter Topology Effort, Second Report," David Taylor Technical Report DTRC-PAS-91/51, February 1992.

The David Taylor Matrix Converter Project advanced in several areas. An improved switching technique for the power semiconductors, known as "staggered commutation," was designed and implemented in the matrix converter hardware. This new communication method should eliminate the voltage spikes due to small errors in device timing. Computer simulations of the basic and improved Venturini algorithms were performed, and these simulations were used to study the limitations of each algorithm. In addition, simulations were performed to study the performance of the algorithms with respect to input voltage and current harmonics. From the results of the simulations, it was possible to formulate relationships to predict the input/output voltage and current harmonics given a known input condition. Some of the results will be presented at the Summer Computer Simulations Conference in Reno, Nevada, this summer.

COLLINS, Glen C., Assistant Professor, "Electronic

Warfare Scenario Modeling for Expert Decision Aids," *Proceedings of the Twenty-third Annual Pittsburgh Conference on Modeling and Simulation*, Pittsburgh, Pennsylvania, 23 (May 1992).

Current military command and control (C2) or electronic warfare (EW) systems provide no capability for scheduling the platform's hardkill and softkill assets in an integrated manner. Where multiple threats must be dealt with for prolonged periods of time, tactics which maximally and optimally utilize the platform's assets will prove invaluable. Human decision makers, however, may become overloaded under excessively stressful conditions reducing their ability to optimally respond within the imposed time constraints. These limitations point to the need for high speed decision aids or decision automation tools. Two models have been developed to guide the construction of these decision aids. One model represents a generalized engagement incorporating  $m$  threats and  $n$  assets. The second model provides a pattern for the decision-making process itself involving the generation and evaluation of asset deployment schedules and, possibly, an AI component for final schedule selection.

COLLINS, Glen C., Assistant Professor, "Geometric Considerations for Multichannel Sound Reinforcement System Loudspeaker Placement," *Proceedings of the Ninety-second Audio Engineering Society Convention*, Vienna, Austria, March 1992, preprint #3301.

Multichannel sound reinforcement systems can provide natural and realistic imaging of live events only when the loudspeaker placement properly considers the physical geometry of the staging area and the maximum audience viewing angles. Many existing multichannel designs have provided good sound imaging but only for those audience seats which are physically located between the outermost loudspeakers. This paper proposes limits and constraints for loudspeaker placement in order to provide natural sound imaging to the majority of audience seats, even those seats which are at extreme horizontal angles to the stage. The issues of loudspeaker positioning (elevation, front-to-back, and left-to-right), channel coverage areas, device beamwidth, and source-to-channel assignment are examined.

COLLINS, Glen C., Assistant Professor, co-author, "Platform Level Hard-Kill/Soft-Kill Integration and Coordination," Tactical Electronic Warfare Division, Naval Research Laboratory Report, Washington, DC, November 1991.

This paper describes a conceptual computer-based decision support system which integrates and optimizes hardkill and softkill assets for point defense scenarios. Modes of operation, types of displays, system components, and an overall decision model are discussed. Operational modes include on-line, where the system would continuously monitor hostile threats and produce action schedules, and off-line, where the operator can exercise the system as a simulator experimenting with various alternatives. Displays used will provide varying degrees of information compression and will permit the dynamic display of the geographic situation and the action schedules recommended by the system. The decision model provides for situation assessment, action collection, alternative schedule creation, schedule evaluation and optimization, schedule selection, and deployment.

COLLINS, Glen C., Assistant Professor, co-author, "Organizing and Understanding Beliefs in Advice-Giving Diagnostic Systems," *IEEE Transactions on Knowledge and Data Engineering*, 3, 3 (September 1991), 269-280.

Intelligent systems that can organize and assist in understanding beliefs in diagnostic problems require architectures significantly different from traditional rule-based shallow reasoners or model-driven reasoners. In this paper, reasoning based on a combination of belief-functions and cause-effect hierarchies is used to create a methodology for enhanced evidential reasoning. A description of the methodology is given, as well as examples of the utilization of a completed system.

LIM, Tian S., Associate Professor, "Microcomputer-Based Frequency Meter Design," *CoED Journal* (Computers in Education Division of ASEE), 1, 3 (July-September, 1991), 41-45.

This paper describes a microcomputer-based digital design laboratory exercise offered by the Department of Electrical Engineering at the United States Naval Academy. In this undergraduate laboratory exercise, the Apple IIe functions as a simple frequency meter that measures and displays the frequency of a signal source when commanded to do so by the closure of a push-button switch.

The Apple does this by reading two game connector inputs, one connected to the square wave signal under measurement, the other to the push-button switch. The software that controls the process consists of an assembly language program that measures the period of the square wave, and a floating point BASIC program that calculates and displays frequency. Another assembly language subroutine is used to display the frequency measurement on the computer monitor.

LIM, Tian S., Associate Professor, "A Microcomputer-Based EPROM Programmer Laboratory," *Computers in Education Journal*, 1, 4 (October-December 1992), 57-60.

This paper describes a microcomputer interfacing laboratory experiment in which students study the software design and hardware implementation of a simple, microcomputer-based system that programs the 2716 type EPROM.

MARTIN, Richard L., Professor, co-author, "A Comparison of Methods for Simulating Low Dose-Rate Gamma Ray Testing of MOS Devices," *IEEE Transactions on Nuclear Science*, 38, 6 (December 1991), 1560-1566.

A radiation testing procedure was developed and experimentally verified in which a series of high dose-rate irradiations, with 100 degree C annealing under bias between irradiations, was used to simulate a continuous low dose-rate irradiation. This approach was found to reduce low dose-rate testing time by as much as a factor of 100 with respect to actual low dose-rate irradiations. In addition to being applicable for both hardened and commercial devices, the procedure also provides detailed information on the behavior of CMOS parts at low dose-rates which are of interest to many satellite applications.

WEIS, R. Stephen, Assistant Professor, co-author, "Fiber-optic Two-beam Interferometer Fringe Amplitude Recovery Using Laser Frequency Control," *Applied Optics*, 1992.

The recovery of interference fringe amplitude by controlling only the laser current is demonstrated. Control of the interfering beams polarization states is not required. The effective retardance of a coil of high birefringence fiber was controlled by changing the wavelength of the system instead of changing its physical length.

WOOTEN, Curran, Instructor, "Modeling the Control of Flight Locomotion in a Locust," *Proceedings of the Twenty-third Annual Pittsburgh Conference on Modeling and Simulation*, 23 (May 1992).

Can the physiological results of individual neurons in insects, which help experimenters determine proposed interconnections of networks, be used in simulation programs to further develop models to provide insight into the control mechanisms of the networks? Artificial neural networks are being used to provide a general model of a system (such as insect locomotion) which, through weighing

structures and learning patterns, can provide the specific functional output. These networks are very powerful and can be modified easily to change their output, but these do not model the actual neural structure of the original system. By using networks of the proposed neural structure, based upon physiological evidence of the interconnections of elements, in neural simulation programs, specific control of portions of the system and control of the developed model can be investigated. These networks may lead to a better understanding of the morphology of the structure and to new implementations of control for a specific function.



## Presentations

BUTKA, Brian K., Assistant Professor, "A Model of Narrow-Bandgap Degenerate p-n Diodes," Twenty-third Annual Pittsburgh Modeling and Simulation Conference, Pittsburgh, Pennsylvania, 29 April 1992.

BUTKA, Brian K., Assistant Professor, "Engineering Applications of Modeling," Session Chairman, Twenty-third Annual Pittsburgh Modeling and Simulation Conference, Pittsburgh, Pennsylvania, 29 April - 1 May 1992.

COLLINS, Glen C., Assistant Professor, "Electronic Warfare Scenario Modeling for Expert Decision Aids," Twenty-third Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 30 April - 1 May 1992.

COLLINS, Glen C., Assistant Professor, "Geometric Considerations for Multichannel Sound Reinforcement System Loudspeaker Placement," Ninety-second Audio Engineering Society Convention, Vienna, Austria, 24-27 March 1992.

WEIS, R. Stephen, Assistant Professor, "Interferometric Measurements of Linewidth and Phase Noise of an Er-Doped Fiber Ring Laser," Eighth Annual Optical Fiber Sensor Conference, January 1992.

WOOTEN, Curran, Instructor, "Modeling the Control Flight Locomotion in a Locust," Twenty-third Annual Modeling and Simulation Conference, University of Pittsburgh, Pittsburgh, Pennsylvania, 30 May 1992.





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# Mechanical Engineering

Professor John O. Geremia  
Chair

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**R**esearch in the Mechanical Engineering Department encompassed several areas of specialization within the broad field of mechanical engineering. These areas included internal combustion engines, fluid dynamics, mechanical and thermal design, and materials science. Specific objectives of the current research varied from computer modeling of centrifugal pumps to the development of advanced composites and ceramic materials research. Research was supported by a variety of sponsors, including the Office of Naval Research, the Nuclear Regulatory Commission, and the David Taylor Research Center. The Academic Dean funded several faculty members on instructional development projects. In addition, some faculty pursued independent research in areas of personal interest.

Research efforts at the Naval Academy are driven by the need for faculty to stay abreast of rapidly changing technology and subsequently to introduce that new technology into their courses. Some updating of course material is also facilitated by seminar speakers and visiting professors. The efforts of the mechanical engineering faculty to become more effective classroom teachers through their research activities are reflected by their numerous publications and presentations at national and international conferences.





## Sponsored Research

### Evaluation of the Impact of Decentralized Cooling Systems on Future Submarines

Researcher: Associate Professor Elliott E. Dodson

Sponsor: David Taylor Research Center, Annapolis Laboratory

The future availability of chlorinated fluorocarbon refrigerants for use in naval chilled-water plants is threatened by environmental concerns. Thermoelectric cooling is an alternative that was evaluated for SSN 21 in 1984 by the Electric Boat Division of General Dynamics Corporation. The process was found to be heavier and less efficient than vapor compression cooling.

The data used in the Electric Boat study was modified by DTRC to include technological advancements in design and thermoelectric material performance; the results are presented in this report. Modification involved the entire heating, ventilating, and air conditioning system (with evaluations of several optional configurations) and the waste heat rejection system.

A decentralized heating, ventilating, and air conditioning system with an environmentally acceptable cooling system, combined with decentral-

ized passive through-the-hull cooling panels, showed potential reductions of 200,000 lb and 2,500 ft<sup>3</sup>, and no increase in power. Changing to a decentralized system would reduce the weight for distribution in centralized systems. Decentralized cooling would reduce submarine cost due to modular construction and because a major portion of ventilation ducting would be eliminated. The decentralized system would also provide increased survivability, arrangement flexibility, and reduction of the acoustic signature.

Recommendations for future work required to overcome major obstacles and to demonstrate the advantage of decentralized cooling are presented.

For the period 16 June 1992 to 15 August 1992 work was extended in order to accomplish ventilation system cost data, so as to permit analysis of the impact of alternative HVAC system configurations for SSN 21.

### Effect of Environment on the Mechanical Behavior of Composite Materials

Researcher: Professor Dennis F. Hasson

Sponsor: Office of Naval Research

Materials are required for advanced high performance structured designs and high temperature components. Engineered materials, such as organic, metal, and ceramic matrix composites (OMC's, MMC's and CMC's) are candidates to fulfill these requirements. A broad program with the support of Lieutenant Michael K. Hamm, USN, is underway to determine the effect of environment on the mechanical behavior of these materials.

One environment for OMC materials is a freeze/thaw cycle of structural elements which gain seawater from long term immersion at high pressure. Preliminary results on E glass/J2 subjected to 1 to 10 freeze/thaw cycles did not exhibit significant mechanical behavior degradation. This OMC, however, is not representative of planned material applications. Further studies are

currently underway on more appropriate OMC materials, such as E glass/3501-6 and AS4/3501-6 fiber/matrix systems. This program is a joint venture with Dr. T. Juska, Naval Surface Warfare Center-Annapolis Detachment.

A MMC program of great importance is the *in situ* processing of particulate reinforced aluminum alloys at Drexel University by Professor M. Koczak's group. Impart tests and scanning electron microscope (SEM) fractography were performed on some sample material. Newer material with improved process control will also be impact tested, and there is a preliminary effort to study the possibility to perform creep tests.

The research on impart testing of CMC materials continues. Room temperature tests in flexure have been performed on Nicalon/CAS materials. Impart tests at 700°C are planned.

## **Evaluation of Corrosion Resistance of Topside Fasteners for Aegis Class Cruisers**

Researchers: Associate Professor Patrick J. Moran  
and Instructor Walter S. Laird  
Sponsor: Naval Surface Warfare Center (White Oak)

This program is investigating the corrosion resistance of several new protective coatings for topside fasteners (bolts and nuts) for Aegis Class Cruisers. The mechanical integrity of the coatings

and their resistance to seawater exposure are being evaluated. The development of a short term electrochemical test to predict long term performance of these fasteners is also underway.

## **Investigation of the Crevice Corrosion of Alloy 625 in Seawater**

Researchers: Associate Professor Patrick J. Moran  
and Engineering Technican John Hein  
Sponsors: Naval Academy Research Council (ONR) and  
David Taylor Research Center, Annapolis Laboratory

Alloy 625 is a NiCrMoFe alloy and is the main piping material in the new SSN21's. Alloy 625 has excellent mechanical and welding properties and, with the exception of crevice corrosion, excellent corrosion properties. It has been found to be susceptible to crevice corrosion in seawater service. David Taylor Research Center is the main Navy laboratory evaluating the problem. Crevice corrosion occurs because acidic environments develop in crevices due to hydrolysis of the metal corrosion products (cations) which concentrate in the restricted crevice. One of the difficulties in modeling crevice corrosion processes or in proposing solutions is that it is not known in what proportion the Ni, Cr, Mo, and Fe dissolve from the Alloy 625 surface in the crevice environment. These elements control the extent of acidity.

In this research project specimens which have experienced crevice corrosion are being carefully analyzed with scanning electron microscopy and x-ray microanalysis to determine the concentration of

the Ni, Cr, Mo, and Fe remaining at the attacked sites. Specimens with varying amounts of crevice corrosion attack were obtained from David Taylor Research Center. Comparison of the concentration of the attacked regions with the normal alloy concentration is allowing determination of exactly what elements dissolved into the crevice region and promoted the aggressive environment. Such information will lead to better modeling of the crevice corrosion process for Alloy 625, which will allow the severity of attack in various crevice geometries to be predicted accurately and will assist efforts to develop control measures and alternative materials. Upon completion of this analysis the author plans to approach a commercial alloy producer to produce test heats of alloys with similar concentrations of alloy 625 but with modifications intended to reduce the crevice corrosion. Evaluation of the modified alloys will be conducted in laboratory tests at the United States Naval Academy.

## **Modal Interactions in the Nonlinear Dynamics of Composite Shell Panels**

Researcher: Assistant Professor Raouf A. Raouf  
Sponsor: Naval Academy Research Council (ONR)

Due to their superior strength characteristics and light weight, composite materials, such as fiber-reinforced and laminated constructions are gaining an ever-increasing popularity in engineering

applications. Composite structures are expected to perform in severe operational conditions, driving them into their nonlinear regimes. However, much of the nonlinear behavior of these structures is

unexplored.

This study uses a combination of numerical and analytical techniques to investigate, understand, and characterize the complex dynamical responses of composite shell panels. The study investigates the vibrations of symmetrically laminated Graphite/Epoxy composite panels using a combination of numerical and analytical techniques. The symbolic manipulator MATHEMATICA is

used to derive the nonlinear equations of motion and discretize the spatial domain using a Rayleigh-Ritz procedure. This study shows that the nonlinearities are important even if the amplitudes of motion are small and in the regions where the linear theories have been classically employed and considered adequate. The response of the panel is shown to be of the hardening type.

### **Improved Characterization of Crash Severity**

Researcher: Professor Russell A. Smith

Sponsor: University of North Carolina

The purpose of this project is to determine whether it is possible to create an improved means of characterizing crash severity by utilizing additional data variables already present in the North Carolina statewide crash data files. Here crash severity refers to a variable that describes the "potential" for injury to a crash-involved occupant of a motor vehicle as a consequence of those factors that influence vehicle acceleration. Also, the term "improved characterization" designates a new scale that will account for more injury variance than the present deformation rating scale (TAD). The desirability of this goal lies in the use of crash

severity as a control variable in research aimed at evaluating designs. One almost always wishes, in such analyses, to control for crash severity, and the better the control variable, the more discerning can be the analyses. At present, crash severity in the North Carolina data is best characterized through the use of a seven-point deformation rating scale. The improved characterization would include a single variable that is sensitive to damage, object struck, and mass.

Work was initiated in 1990, and an algorithm has been developed. Test and evaluation of this algorithm will occur in 1992.

### **Influence of Heat Treatment on the Corrosion Properties of Stainless Aluminum Alloys**

Researcher: Midshipman 1/C Frederick G. Schenk, USN

Adviser: Associate Professor Patrick J. Moran

Sponsor: Trident Scholar Program

Aluminum alloys are used extensively in the U.S. Navy and range from light weight, high strength aircraft components to super-structures on ships. Corrosion problems are commonly encountered with these materials. The elements typically added to aluminum to improve mechanical properties (such as copper, magnesium, and zinc) generally do not increase the corrosion resistance. However, a new class of aluminum alloys with exceptional corrosion resistance, referred to as "stainless aluminum alloys," has been developed by the Naval Research Laboratory. These materials involve alloying elements which specifically increase the aluminum alloy's ability to resist corrosion; materials such as tantalum, tungsten, silicon, molybdenum, and chromium. These elements help to form a more protective passive film on the aluminum surface which dramatically improves the corrosion resistance. Unfortunately, these elements

have limited solubility in the aluminum crystal structure, and if they are processed by conventional means or if they are heated after processing, additional phases develop and the alloying element will no longer be in the aluminum matrix and will therefore not develop the enhanced corrosion resistance. Therefore, these materials must be processed by fast solidification methods which trap the alloying element in the parent aluminum phase.

This project is evaluating two rapid solidification processing methods, spray forming and sputter deposition, for the production of these alloys. The research also evaluates the influence of subsequent heat treatment on their corrosion properties. Aluminum-tungsten and aluminum-tantalum alloys are being investigated, because these two alloys have shown the best corrosion resistance of all the systems tested to date.

## Independent Research

### Control Hinge Moment Coefficients

Researcher: Professor Joseph D. Gillerlain, Jr.

Experimental measurements of the hinge moment coefficients for a control fin having the geometric characteristics of an NACA 0012 airfoil were made in wind tunnel tests. The results are being compared with predictions from linear theory and

with other available data. Applications lie in the areas of canard control surfaces and SWATH stabilizer surfaces. Commander Vernon Gordon, USN, formerly of the Aerospace Engineering Department, collaborated on this effort.

### High Temperature Impact Testing

Researchers: Professor Dennis F. Hasson and  
Lieutenant Michael K. Hamm, USN

Ceramic and intermetallic matrix composites are materials which have the potential for use in high temperature structural and engine applications. Their ability to exhibit high fracture toughness (i.e., ability to absorb impact) is of great importance. An instrumental drop tower impact test apparatus has been modified and instrumented to perform impact tests up to 1100°C. An apparatus which utilizes infrared heating from focused quartz lamps has

been designed and fabricated. An equilibrium temperature of 1100°C can be attained in 3 minutes. The apparatus has been utilized to examine the impact behavior of a Ti-49al intermetallic reinforced with 5 volume percent TiB<sub>2</sub>. The reinforcement was introduced by the XD process. Preliminary results show a decrease in impact and flexure strength with increasing temperature. Scanning electron microscopy is in progress.

### Constraint Effects on Elastic Plastic Fracture

Researcher: Professor James A. Joyce

This is a new effort for United States Naval Research Center to develop a connection methodology to relate small scale surveillance specimens to large structural applications, like the nuclear reactor containment vessel. Analytical and numerical work is being sponsored at the University of Illinois and Brown University, and experimental work is being done at the David Taylor Research

Center and the United States Naval Academy. Tests are being conducted on a range of geometries and specimen sizes, and the new Q parameter is being utilized to relate the small specimens to the large specimen results. Both transitional and upper shelf testing and analyses are being conducted. The U.S. Nuclear Regulatory Commission also provided support for this project.

### Variable Amplitude Fatigue Testing

Researcher: Professor James A. Joyce

This project is directed toward developing a computer-controlled variable amplitude test system that can apply realistic load histories to specimens and structural elements. A PC controller with

internal A/D and D/A circuit cords has been developed which can generate the variable amplitude control signal needed by the servohydraulic machine, as well as measure the

specimen compliance and crack length. The first results were presented in June 1992, and additional specimen tests will be conducted next year to vali-

date the method, hardware, and software. This project was also supported by the Turner Fairbanks Federal Highway Research Center.

### **Potential Flow Analysis of the Forces on a Laboratory Centrifugal Pump Impeller**

Researcher: Assistant Professor Steven M. Miner

Two-dimensional potential flow was used to determine the pressure field in a laboratory centrifugal pump. The impeller and volute were modeled simultaneously, using the finite element technique. Simulation of impeller rotation was accomplished by generating steady state solutions with the impeller in 10 different angular orientations within the volute. As a result, the interaction between the impeller and volute developed naturally as a result of the solution. Model results showed that blade pressure profiles were asymmetric, even at design flow. These asymmetries were even more pronounced at off design flow rates. The causes of these asymmetries were examined in terms of the

interaction between the impeller, and the tongue and scharge regions of the volute. In addition, the blade pressure profiles were integrated to determine the impeller unbalance force. The forces were calculated at design and off flow rates. The frequency content of the forces was also examined. Fluctuating components of force, due to impeller rotation, were found to be on the order of 30% of the static force. Finally, a comparison was made between the computationally determined forces and measured forces reported in previous studies. This research was supported by Ingersoll-Rand Company.

### **CFD Modelling of the Flow over Board-Mounted Electronic Components**

Researcher: Assistant Professor Steven M. Miner

This work is just beginning; the researcher seeks to model the flow field around board-mounted electronic components. FLOTRAN is being used to do the CFD analysis. The computational results will be compared to experimental data available from Bell Laboratories. Currently, finite element meshes for the flow have been generated, and some preliminary runs have been made. Both 2-D and 3-D flow fields will be considered.

The findings have application in the prediction of

reliability for electronic assemblers. The assembly reliability is a function of the reliabilities of the individual components in the assembly, and these component reliabilities are a function of their generating temperature. The component operating temperature is determined by the coolant temperature and the flow of the coolant around the component. Thus the study is aimed at determining the component heat transfer coefficient by modeling the flow around the components.

### Gas-Cooled Nuclear Reactor Brayton Cycle

Researchers: Professor Chih Wu and  
Lieutenant Commander Rodney Adams, USN

Modern warships in the U.S. Navy are propelled by one of two types of engines. Small-to-medium sized surface combatants use gas turbine engines for their high power-to-weight ratio, ease of maintenance and operation, rapid response, and relatively low cost. Aircraft carriers and submarines use pressurized water nuclear reactors, due to their unlimited endurance (years between refuelings), high total power production, and lack of dependence on oxygen or need for exhaust. This situation has been accepted for lack of better alternatives.

It is possible, by combining proven technologies,

to produce a closed cycle gas turbine engine in which the gas is heated by a nuclear reactor. The characteristics of the engine would include rapid start capabilities, high power-to-weight ratio, independence from fuel supply lines, small total plant volume, independence from oxygen, zero air pollution, a low thermal signature, a high level of plant safety, relative ease of maintenance, and acceptable lifetime cost. This is not a perpetual motion machine or something out of science fiction; it is achievable in the near term.



## Research Course Projects

### Prevention of Crevice Corrosion on YP Stainless Steel Shaft Materials

Researchers: Midshipmen 1/C Martin S. Rusnak and  
Taylor N. Thorson, USN

Advisers: Associate Professor Patrick J. Moran  
and Engineering Technician John Hein

The United States Naval Academy YP Craft are experiencing crevice corrosion of the stainless steel shafts and the stainless steel shaft couplings. Cathodic protection has been successfully utilized to prevent this problem; however, the zinc anodes used to supply cathodic protection are quickly consumed and there is concern about polarizing the materials too far and possibly encountering hydrogen embrittlement. It is possible to couple the zinc

anodes to the stainless steel materials through an electrical resistance and control the extent of cathodic protection supplied. By not polarizing the stainless steel any further negative than necessary to prevent the crevice corrosion the zinc anode life would be maximized. This project is determining the minimum amount of cathodic protection necessary to prevent crevice corrosion of the stainless steel materials involved.

### Tidal Power Plant

Researcher: Midshipman 1/C Scott G. Springer, USN  
Adviser: Professor Chih Wu

The Annapolis Project was initiated to test new tidal power technologies in the Bay of Fundy. The project constructed a 20 MW tidal power plant in the Annapolis Basin by the town of Annapolis Royal in Nova Scotia. The tidal plant uses a single effect

with a single basin to generate power while emptying and sluices while filling. Using new construction techniques and a Straflo turbine, the plant was completed and began operation in August 1984.

### A Feasibility Study of Nuclear Waste Vitrification Techniques

Researcher: Midshipman 1/C Andrew F. Sullivan, USN  
Adviser: Professor Chih Wu

Technologies capable of solving the problems of Department of Energy mixed waste are at various levels of development. At this point, thermal treatment is receiving the lion's share of attention. The intent of this paper is to discuss several of the technologies under consideration. The discussion is divided into several sections. These partitions begin with a description of the thermal process upon which various corporations have based their designs. Following this, the specified technologies

falling under the classification are discussed, including a physical description of the system and an examination of possible limitations and probable capabilities. The thermal technologies and associated companies are: (1) Joule-Heated Melters, Duratek, Inc. and Glasstech, Inc.; (2) Plasma Torch Melters, MSE, Inc. and Westinghouse, Inc.; (3) DC Arc Furnace, Electro-Pyrolysis, Inc.; and (4) Fossil Fueled, Vortec, Inc.

## Publications

ERPELDING, Peter, Lieutenant, USN, "Determination of Radiative Fluxes in an Absorbing, Emitting, and Scattering Vapor Formed by Laser Irradiation," *American Society for Mechanical Engineers Journal of Heat Transfer* (November 1991), 939-945.

A two-dimensional computer model was developed to determine the heat flux distribution within the metal plasma formed above a metal target irradiated by a laser beam. The P-1 and P-3 spherical harmonics approximations were used to solve the radiative transfer equation. The P-1 approximation reduced the radiative transfer equation to one elliptic partial differential equation. The higher order P-3 approximation reduced the radiative transfer equation to four elliptic partial differential equations. The resulting equations were then solved for the radial and axial heat fluxes using a finite difference algorithm.

Comparisons were made and found to be in good agreement with available analytical results. The model confirmed that the P-1 approximation yielded more reliable results when the medium was optically thick. In cases where the medium was optically thin, the P-3 approximation provided the best results.

Although many solutions to the radiative transfer equation have been obtained by means of the P-N approximation, the bulk of these have focused on the heat transfer rates for a variety of surface radiative properties in rectangular and cylindrical enclosures. Only limited efforts have been directed toward study of an external collimated beam incident upon an enclosure surface. This study is unique in that the spherical harmonics approximation is used to examine the heat transfer rates within a cylindrical enclosure irradiated at the top surface by a laser beam.

JOYCE, James A., Professor, "Quantification of Engineering Limits to J Control of Ductile Crack Growth," *Elastic-Plastic Fracture Test Methods: The User's Experience* (Second Volume), ASTM STP 1114, ed. J. A. Joyce, Philadelphia: American Society for Testing and Materials, 1991, pp. 57-80.

The J-integral has been developed as a ductile fracture parameter over the past 15 years and has been applied to an ever-expanding range of applications and materials. Limits originally placed on the application of J by analytical considerations

have, in most cases, proven too stringent and in some cases the analytical limits have even seemed to be inapplicable or irrelevant. This has been particularly true of the omega ( $\omega$ ) criterion introduced by Hutchinson and Paris. Experimental work has seemed to show little correspondence between the limits predicted by this criterion and the experimentally measured size limitations.

Recent experimental work by Joyce et al. has shown that the J-integral is applicable to much larger crack extensions than previously proposed. Using these experiments, Joyce and Hackett have proposed an experimental method to define the limit to J-integral controlled crack growth.

This paper now shows that the  $\omega$  criterion is consistent with the collected data set, except that the limiting value for  $\omega$  is on the order of one, not the value of 5 to 10 originally proposed. Three simple analyses are presented using the criterion to develop proposed limits on J and crack extension that can be used in a predictive manner for fracture analysis.

JOYCE, James A., Professor, co-author, "Evaluation of Elastic Stress Intensity Using J-Integral Specimen Geometries," *Journal of Testing and Evaluation*, JTEVA, 20, 1 (January 1992) 1-5.

The development of a "Common Test Method" for fracture mechanics toughness evaluations requires changes in the test specimens used for evaluation of the elastic critical stress intensity factor  $K_{Ic}$ . The present method, ASTM E 399, does not allow the use of side grooves and load-line crack opening displacement measurements as is common and necessary for J-integral and CTOD elastic-plastic fracture methods like ASTM E 813, E 1152, and E 1290. This paper presents experimental data on two materials that demonstrate that the J-integral type specimen can be used to evaluate  $K_{Ic}$  in an accurate fashion and that hence a true "Common Method" is possible.

The basic conclusions are that if the secant offset slope is varied to correspond to 2% crack growth, the  $K_Q$  values measured from specimens with a/W ratios between 0.55 and 0.7 are indistinguishable from standard results. Side grooves do not affect the results as long as an effective specimen thickness is used for the  $K_Q$  evaluation, and the J-type load-line cutouts appear to have no effect on the measured  $K_Q$  results.



JOYCE, James A., Professor, co-author, "Dynamic Fracture Toughness of Modified SA508C12 in the Ductile-to-Brittle Transition Region," *Elastic-Plastic Fracture Test Methods: The User's Experience* (Second Volume), ASTM STP 1114, ed. J. A. Joyce, Philadelphia: American Society for Testing and Materials, 1991, pp. 273-288.

Fracture toughness testing of steels in the ductile-to-brittle transition region is complicated by a high degree of data scatter. Variations in the amount of ductile tearing prior to cleavage initiation often accompany the data scatter. Dynamic toughness testing is shown to be experimentally successful at reducing the incidence of prior ductile tearing. For the displacement rates tested, dynamic toughness values are at or above the lower-bound static toughness. Analysis of transition region toughness data using Weibull statistics, available energy analysis, and a constraint correction procedure is discussed.

JOYCE, James A., Professor, co-author, "Development of an Engineering Definition of the Extent of J-Controlled Crack Growth", *Defect Assessment of Components - Fundamentals and Applications*,ESIS/EGF9, eds. J. G. Blauel and K. H. Schwalbe, London: Mechanical Engineering Publications, 1992, pp. 233-249.

An experimental definition is proposed for the extent of J-integral controlled behavior in a J-resistance fracture test. The J-control zone is defined in terms of a constant ratio of plastic crack opening displacement and normalized crack extension. Justification for this definition is given in terms of experimental results on compact specimens of three steel alloys of varying material toughness.

The experimental limit can be evaluated from the data normally obtained during an unloading compliance single specimen J-integral resistance curve experiment. Generally the experimental singularity limit extends the region of test validity well beyond that which is presently allowed by the ASTM J-R test standard, E1152.

JOYCE, James A., Professor, "Pressure Vessel Integrity - 1991," PVP, Vol. 213, New York: American Society of Mechanical Engineers, 1991, pp. 73-79.

The J-integral fracture mechanics methodology uses a single parameter, the J-integral, to characterize the intensity of the crack tip field for both crack initiation and crack growth. This parameter is intended to be applicable whether the applied loading is predominantly tensile or predominantly bending and, in general, laboratory specimens are tested in a bending mode while the applications are often predominantly tensile. Several recent large

scale tests conducted in the U.S. and in Europe and analyzed as part of the Committee on the Safety of Nuclear Installations (CSNI) project FALSHIRE have shown that, in at least some cases, the J-integral at initiation, and the J-R curve in general, can be distinctly elevated for predominantly tensile loadings when compared to bending specimen results.

Recent analysis by Betegon and Hancock (1991) and by O'Dowd and Shih (1990) proposes that a second parameter is needed to characterize the crack tip field in terms of the crack tip triaxiality or constraint, and that the  $J_{Ic}$  or J-R curve can vary markedly for specimens of distinctly different constraint. To understand this developing issue, specimen geometries with a predominantly tensile mode of loading must be developed and tested. In this work, double and single edge notched specimens are developed which produce a tensile mode of loading, can be easily precracked in bending, and can be loaded to produce ductile crack growth and failure in the test laboratory. These specimens are much cheaper to test and should allow a reasonably simple finite element analysis as far as their full 3-D characterization is concerned. Preliminary tests on two structural steel alloys show that these geometries do demonstrate the predicted elevation of both  $J_{Ic}$  and of the J-R curve which has generally only been observed in expensive wide plate tests, surface crack tests, or pressurized cylinder tests.

JOYCE, James A., Professor, co-author, "Elastic Plastic Characterization of a Cast Stainless Steel Pipe Elbow Material," U.S. Nuclear Regulatory Commission Report, NUREG/CR-5774, January 1992.

Tests conducted in Japan as part of the High Level Vibration Test (HLVT) program for reactor piping systems revealed fatigue crack growth in a cast stainless steel pipe elbow. The material tested was equivalent to ASME SA351CF8M. The David Taylor Research Center (DTRC) was tasked to develop the appropriate material property data to characterize cyclic deformation, cyclic elastic-plastic crack growth and ductile tearing resistance in the pipe elbow material.

The tests conducted included monotonic and cyclic tensile tests, monotonic J-R curve tests, and cyclic elastic and elastic-plastic fatigue crack growth rate tests. The cyclic elastic-plastic fracture behavior of the stainless steel was of primary concern and was evaluated using a cyclic J-integral approach. The fracture surfaces of selected specimens were examined in a scanning electron microscope (SEM) to determine the operative fracture micro-mechanism(s).

It was found that the cast stainless steel was very resistant to ductile crack extension. J-resistance

curves essentially followed a blunting behavior to very high J levels. High cycle fatigue crack growth rate data obtained on this stainless steel was typical of that reported in standard textbooks. Low cycle fatigue crack growth rate data obtained on this material using the cyclic J integral approach was consistent with the high cycle fatigue crack growth rate and with a standard textbook correlation equation typical for this type of material. Evaluation of crack closure effects was essential to accurately determine the crack driving force for cyclic elastic-plastic crack fracture surfaces indicated that fatigue was the primary mode of fracture with ductile crack extension intervening only during the last few cycles of loading. SEM examination also revealed secondary fatigue cracks which propagated inward from the side grooves for the  $R = 0$  and  $R = 0.3$  specimens. These secondary cracks were likely the cause of observed inaccuracies in the compliance estimated crack lengths for these specimens.

MINER, Steven M., Assistant Professor, co-author, "Turbulence Measurements in a Centrifugal Pump with a Synchronously Orbiting Impeller," American Society of Mechanical Engineers Paper 91-GT-70, June 1991, *Journal of Turbomachinery*, 114, 2 (April 1992), 350-359.

Turbulence profiles were measured in a centrifugal pump with an impeller with backswept blades using a two-directional laser velocimeter. Data presented include radial, tangential, and cross product Reynolds stresses. Blade-to-blade profiles were measured at four circumferential positions and four radii within and one radius outside the four-bladed impeller. The pump was tested in two configurations: with the impeller running centered within the volute, and with the impeller orbiting with a synchronous motion ( $\epsilon/r_2 = 0.016$ ). Flow rates ranged from 40 to 106 percent of the design flow rate. Variation in profiles among the individual passages in the orbiting impeller were found. For several regions the turbulence was isotropic, so that the cross product Reynolds stress was low. At low flow rates the highest cross product Reynolds stress was near the exit. At near-design conditions the lowest cross product stress was near the exit, where uniform flow was also observed. Also, near the exit of the impeller the highest turbulence levels were seen near the tongue. For the design flow rate, inlet turbulence intensities were typically 9 percent and exit turbulence intensities were 6 percent. For 40 percent flow capacity the values increased to 18 and 19 percent, respectively. Large local turbulence intensities correlated with separated regions. The synchronous orbit did not increase the random turbulence, but

did affect the turbulence in the individual channels in a systematic pattern.

MINER, Steven M., Assistant Professor, co-author, "Pressure Distributions in a Single and Two Versions of a Double Volute of a Centrifugal Pump," American Society of Mechanical Engineers Paper 92-GT-20, June 1992.

Pressure measurements were recorded around the impeller and along the casing wall of a centrifugal pump, 0.60 (1583 US units) specific speed, assembled with a single volute/single discharge. The latter comprised a splitter positioned in the second half of the discharge (i) midway between the impeller and casing, and (ii) along a spiral symmetric to the first-half casing section. The objective of such double volute casings is to reduce forces on the impeller and thus provide longer lives. Flow rates tested ranged from 20% to 105% of design. A repeated pattern consisted of pressure increasing from the first cutwater to the splitter leading edge at which the pressure drops and thereafter increases to the discharge. This pattern was noted at all flow rates with the symmetric volute geometry and only at flow rates higher than 60% for the centered splitter. By integration forces ranged from 6.2 N at design to 33.0 N at 20% flow for the single volute. Both double volute configurations showed considerable thrust reduction throughout but for a few exceptions. Reductions ranged from 26% at 30% flow to 62% at 90% flow for the center splitter, and from 52% reduction at 20% flow to 72% at 80% flow for the symmetric splitter. For comparison of performance of the different configurations, at flow rates above 85% of design, the head was 8% and 9% less for the double volutes than for the single volutes. At flows below 40% of design, the head was 3% and 4% higher for the double volutes than for the single volute.

MINER, Steven M., Assistant Professor, co-author, "Potential Flow Analysis of the Forces on a Laboratory Centrifugal Pump Impeller," American Society of Mechanical Engineers Paper 92-GT-285, June 1992, and Division of Engineering and Weapons Report EW-18-91, November 1991.

Two-dimensional potential flow was used to determine the pressure field in a laboratory centrifugal pump. The impeller and volute were modeled simultaneously, using the finite element technique. Simulation of impeller rotation was accomplished by generating steady state solutions with the impeller in 10 different angular orientations within the volute. As a result, the interaction between the impeller and volute developed naturally as a result of the solution. Model results showed

that blade pressure profiles were asymmetric, even at design flow. These asymmetries were even more pronounced at off design flow rates. The causes of these asymmetries were examined in terms of the interaction between the impeller, and the tongue and discharge regions of the volute. In addition, the blade pressure profiles were integrated to determine the impeller unbalance force. The forces were calculated at design and off flow rates. The frequency content of the forces was also examined. Fluctuating components of force, due to impeller rotation, were found to be on the order of 30% of the static force. Finally, a comparison was made between the computationally determined forces and measured forces reported in previous studies.

MINER, Steven M., Assistant Professor, co-author, "Laser Velocimeter Measurements in a Centrifugal Pump with a Synchronously Orbiting Impeller," *Journal of Turbomachinery*, 114, 2 (April 1992), 340-349.

Velocity profiles were measured in the impeller of a centrifugal pump with a two-directional laser velocimeter. Blade-to-blade profiles were measured at four circumferential positions and four radii within and one outside the four-bladed impeller. Data are presented herein at two circumferential and three radial locations. The pump was tested in two configurations; with the impeller running centered within the pump, and the impeller orbiting with a synchronous motion ( $\epsilon/r_2 = 0.016$ ). Variation in velocity profiles among the individual passages in the orbiting impeller were found. At design flow rate, these variations ranged from 30 to 60 percent for the radial component, and 15 to 25 percent for the tangential component. Tangential velocity profiles near the impeller exit ( $r/r_2 = 0.973$ ) were near uniform across each individual passage. Differences in the magnitude of the exit tangential velocities among the passages however, were detected. Systematic differences in the velocity profile shapes of the centered and orbiting impellers were in general not measured, the only exception being at  $r/r_2 = 0.973$  at 40 percent of the design flow rate. At this condition, two distinct radial velocity profiles were measured. Two of the impeller passages of the orbiting impeller contained a recirculation region covering 20-30 percent of the blade passage, while the other two passages contained no recirculation region. The centered impeller also contained this region of reverse flow. Finally, velocity data were numerically integrated to find the forces and stiffnesses due to momentum fluxes on the impeller for the orbiting condition.

MINER, Steven M., Assistant Professor, co-author, "Two-Dimensional Flow Analysis of a Laboratory Centrifugal Pump," *Journal of Turbomachinery*, 114, 2 (April 1992), 333-339.

Two-dimensional potential flow was used to determine the velocity field within a laboratory centrifugal pump. In particular, the finite element technique was used to model the impeller and volute simultaneously. The rotation of the impeller within the volute was simulated by using steady-state solutions with the impeller in ten different angular orientations. This allowed the interaction between the impeller and the volute to develop naturally as a result of the solution. The results for the complete pump model showed that there are circumferential asymmetries in the velocity field, even at the design flow rate. Differences in the relative velocity components were as large as 0.12 m/s for the radial component and 0.38 m/s for the tangential component, at the impeller exit. The magnitude of these variations was roughly 25 percent of the magnitude of the average radial and tangential velocities at the impeller exit. These asymmetries were even more pronounced at off-design flow rates. The velocity field was also used to determine the location of the tongue stagnation point and to calculate the slip within the impeller. The stagnation point moved from the discharge side of the tongue to the impeller side of the tongue, as the flow rate increased from below design flow to above design flow. At design flow, values of slip ranged from 0.96 to 0.71, from the impeller inlet to impeller exit. For all three types of data (velocity profiles, stagnation point location, and slip factor) comparison was made to laser velocimeter data, taken for the same pump. At the design flow, the computational and experimental results agreed to within 17 percent for the velocity magnitude, and 2 deg for the flow angle. The stagnation point locations coincided for the computational and experimental results, and the values for slip agreed to within 10 percent.

MORAN, Patrick J., Associate Professor, co-author, "Non-Invasive, High Resolution Detection of Electrical Currents and Electrochemical Impedances at Spaced Localities along a Pipeline," U.S. Patent No. 5-087-873, 11 February 1992.

Electrical currents, caused by intentional ac perturbation of the pipeline, are measured at spaced localities along underground pipelines by measuring the resulting magnetic field at each locality. The corrosion rate of the pipeline at each locality and the quality of the barrier coating on the pipeline can be quantified from these measurements.

MORAN, Patrick J., Associate Professor, co-author, "A Novel Method for Generating Quantitative Local Electrochemical Impedance Spectroscopy," *Journal of the Electro-Chemical Society*, 139, 4 (April 1992), 1007-1012.

A local electrochemical impedance spectroscopy

(LEIS) technique for mapping the ac impedance distribution, as a function of frequency, of an electrode has been developed. In LEIS, as in traditional ac impedance methods, a sinusoidal voltage perturbation between the working and reference electrode is maintained by driving an ac current between the working electrode and a distant counterelectrode with a potentiostat. Local ac impedances are then derived from the ratio of the applied ac voltage and the local ac solution current density. The local ac current density is obtained from potential difference measurements near the electrode surface using a probe consisting of two micro-electrodes. By measuring the ac potential difference between the micro-electrodes, and knowing their separation distance and the solution conductivity, the local ac solution current density is derived.

The accuracy of the local ac impedance data generated with this technique was established by investigating two model systems. The first provided an homogeneous electrode which allowed LEIS measurements to be compared to traditional EIS, while the second system provided an heterogeneity of known size and location whose components were easily characterized with traditional techniques. It is shown that area-normalized scanning ac impedance measurements of the homogeneous electrode agreed well with traditional results. In addition, because LEIS maps the impedance properties of an electrode, the defect in the heterogeneous electrode was easily detected, while traditional ac impedance of this electrode gave little indication of its presence.

MORAN, Patrick J., Associate Professor, co-author, "The Passivity of 304 Stainless Steel in Propylene Carbonate Solutions," *Journal of the Electrochemical Society*, 139, 1 (January 1992), 54-60.

The passivation behavior of 304 stainless steel in anhydrous propylene carbonate (PC) containing 0.5M LiAsF<sub>6</sub> or 0.5M LiClO<sub>4</sub> was studied. The air-formed film on 304SS is stable up to the oxidation potential of PC(PC<sub>ox</sub>). Scratch tests show that the bared 304SS surface repassivates in the anhydrous PC solutions of either electrolyte by chemisorption of PC molecules below PC<sub>ox</sub>. In PC/0.5M LiAsF<sub>6</sub> solutions, the 304SS is not passivated at potentials above PC<sub>ox</sub>. In PC/0.5M LiClO<sub>4</sub> solutions the 304SS is passive at potentials 400-500 mV above PC<sub>ox</sub>. This attributed to the formation of a thin metastable perchlorate salt film or an absorbed layer of perchlorate anions. When the perchlorate anions oxidize, the passivation becomes unstable and pitting occurs. Small (3-8 volume percent) additions of PC/0.5M LiClO<sub>4</sub> to PC/0.5M LiAsF<sub>6</sub> solutions raises the passive range to the perchlorate oxidation potential. Small quantities of water, propylene, glycol, and propylene oxide added to PC

slightly improve the passive range of the 304 stainless steel.

MORAN, Patrick J., Associate Professor, co-author, "Analysis of Passive Film Growth by Dynamic Imaging Microellipsometry," *Journal of the Electrochemical Society*, 139, 3 (March 1992), 712-715.

Dynamic imaging microellipsometry (DIM) is a full field, radiometric approach to ellipsometry that provides high spatial resolution and accuracy. This paper reports on the latest DIM system and demonstrates the usefulness of the DIM technique for *in situ* examination of passive film growth on materials with microstructural inhomogeneities. In particular DIM has been utilized to examine passive film growth on a polycrystalline iron sample and an aluminum tantalum alloy that contained intermetallic precipitates. Grain orientation has been observed to affect the growth rate and final thickness of the film on iron. Ellipsometric identification of intermetallic precipitates (approximately 20 μm in diameter) is reported. The precipitates are observed to form a thinner passive film than the matrix. The incompatibility between the film over the precipitate and that over the matrix may degrade the localized corrosion behavior of these alloys.

MORAN, Patrick J., Associate Professor, co-author, "Projection of Improved High Rate Discharge Performance for Homogenized Cathode Li/I<sub>2</sub> (P2VP) Batteries," *Journal of Applied Electrochemistry*, 22 (1992), 99-103.

It has been recently proposed that implementing a cathode with a homogenous distribution of iodine and P2VP into Li/I<sub>2</sub> (P2VP) batteries would be a means of enhancing high rate discharge performance. A procedure for predicting high rate discharge performance gains for such cells is presented. The projected high rate discharge performance for cells with homogenous cathodes is superior to the performance of conventional cells.

MORAN, Patrick J., Associate Professor, "Evaluation of as Received Corrosion Resistant Coatings on Fasteners for Shipboard Topsides Combat Systems," Division of Engineering and Weapons Report EW 10-92.

This report is presented in support of the joint effort between the United States Naval Academy and the Naval Surface Warfare Center in determining the corrosion resistance performance of combat systems topside fastener coating systems.

Information herein details specific findings and observations of as received fastener coating coverage and thickness measurements through the use of precision computerized image analysis

techniques. These observations are then used to predict in service corrosion resistance performance.

The particular commercial coatings evaluated in this report are: (1) Blue Armor II by ISPA, (2) Xylan 101-4 by Lonestar, (3) NiCoTef by Nymet, and (4) IC-531 by Inorganic Coatings.

MORAN, Patrick J., Associate Professor, Walter S. LAIRD, Instructor, and John J. DEBELLIS, Ensign, USN, "Preliminary Evaluation of Selected Corrosion Resistant Fastener Coatings for Shipboard Combat Systems," Division of Engineering and Weapons Report EW-01-92, January 1992.

Five corrosion resistant fastener coatings, currently under review at the United States Naval Academy, are as follows: (1) Nickel-Teflon Co-deposit (electroless); (2) Zinc-Potassium Silicate, water-based, inorganic; (3) Metallic-Ceramic, aluminum oxide based (MIL-Spec); (4) Proprietary PTFE-type Systems; and (5) Zinc Chromate Dispersion (MIL-Spec).

This preliminary report details previous findings on examples of each of the five coating categories and elucidates the best coating(s) for further, concentrated research. This report draws on previous findings and experiments conducted as far back as the early 1970's with the steam catapult corrosion experiments onboard the *USS Saratoga* (CV-60), and it includes the latest findings as published by such organizations as Naval Ships Systems Engineering Station and David Taylor Research Center, in addition to recent magazine and journal publications. The twenty-six coatings listed in the 1976 *USS Saratoga* report, however, are by today's standards, somewhat outdated. Consequently, they are not included in this report, but they are an indication of the rapidly evolving technology in this area of study.

The particular commercial coatings presently in supply, which are to be the specimens in the evaluation are as follows: (1) Nickel-Teflon Co-deposit by Nymet Co., (2) IC-531 by Inorganic Coatings, (3) Blue Armor II by ISPA Co., and (4) PC1-3 and Xylan 101-1 (PTFE System) by Lonestar.

RAOUF, Raouf A., Assistant Professor, co-author, "Nonlinear Dynamics of Anisotropic Shell Panels," *Proceedings of the Eighth International Conference on Composite Materials Society for the Advancement of Material and Process Engineering*, 1991, pp. 32R1-32R9.

Many of today's marine and aerospace composite structures are expected to function in severe operational conditions pushing them into their nonlinear regimes. Nevertheless, the literature that explores the nonlinear behavior of composite structures is scarce. This paper presents a set of

equations that describe the nonlinear dynamic response of slightly compressible, anisotropic, composite shell panels to external excitations. A combination of Galerkin procedure and the method of multiple time scales is used to construct a procedure, and the method of multiple time scales is used to construct an approximate solution to these equations. The dynamic response of the panel is studied as the frequency of the external excitation is varied. The response of the panel is shown to be nonlinear and experiences complicated dynamic behaviors such as dynamic snap-throughs and multiple solution.

RAOUF, Raouf A., Assistant Professor, co-author, "Nonlinear Response of Infinitely Long Circular Cylindrical Shells to Subharmonic Radial Loads," *American Society of Mechanical Engineers, Journal of Applied Mechanics*, 58 (December 1991), 1033-1041.

The method of multiple scales is used to analyze the nonlinear response of infinitely long, circular cylindrical shells (thin circular rings) in the presence of a two-to-one internal (autoparametric) resonance to a subharmonic excitation of order one-half of the higher mode. Four autonomous first-order ordinary differential equations are derived for the modulation of the amplitudes and phases of the interacting modes. These modulation equations are used to determine the fixed points and their stability. The fixed points correspond to periodic oscillations of the shell, whereas the limit-cycle solutions of the modulation equations correspond to amplitude and phase-modulated oscillations of the shell. The force response curves exhibit saturation, jumps, and Hopf bifurcations. Moreover, the frequency response curves exhibit Hopf bifurcations. For certain parameters and excitation frequencies between the Hopf values, limit-cycle solutions of the modulation equations are found. As the excitation frequency changes, all limit cycles deform and lose stability through either pitchfork or cyclic-fold (saddle-node) bifurcations. Some of these saddle-node bifurcations cause a transition to chaos. The pitchfork bifurcations break the symmetry of the limit cycles.

RAOUF, Raouf A., Assistant Professor, co-author, "Nonlinear Response of Anisotropic Arbitrarily Laminated Shell Panels: An Asymptotic Analysis," *International Journal of Composite Structures*, 18 (1991), 163-192.

An asymptotic procedure is used to derive the nonlinear equations of motion governing the forced dynamic response of an arbitrarily laminated slightly compressible composite shell panel in cylindrical bending. A combination of the Galerkin procedure and the method of multiple time scales is used to

construct a uniformly valid asymptotic expansion for the dynamic response of the panel under near-resonant external excitation, and in the presence of a two-to-one internal resonance condition. A qualitative analysis shows that there is a threshold value for the amplitude of excitation, above which the panel exhibits the saturation phenomenon in which the amplitude of the directly excited mode saturates, and the coupled mode starts to respond nonlinearly and eventually dominates the response. The force-response curve also exhibits the jump phenomenon.

SMITH, Russell A., Professor, co-author, "Tire Faces and Simulation of Vehicle Trajectories," *Accident Reconstruction Journal*, 3, 6 (November 1991), 20-24.

This article reviews the origin and modeling of tire-ground interface forces and their application to motor vehicle simulation in accident reconstruction. Selected results are used to illustrate the disparate effects occurring when a vehicle not under driver control is reacting simultaneously to yaw rotation and translation.

WU, Chih, Professor, co-author, "Power Performance of a Nonisentropic Brayton Cycle," *Transactions of the ASME Journal of Engineering for Gas Turbines and Power*, 113, 4 (October 1991), 501-504.

Work and power optimization of a Brayton cycle are analyzed with a finite-time heat transfer analysis. This work extends the recent flurry of publications in heat engine efficiency under the maximum power condition by incorporating nonisentropic compression and expansion. As expected, these nonisentropic processes lower the power output as well as the cycle efficiency when compared with an endoreversible Brayton cycle under the same conditions.

WU, Chih, Professor, "Optimal Power from a Radiating Solar-Powered Thermionic Engine," *The Journal of Energy Conversion and Management*, 33, 4 (1992), 279-282.

A finite-time thermodynamic analysis is given of the thermionic engine as a direct converter of heat to electricity. The engine is coupled to a radiant solar input and is radiatively coupled to a heat sink. Both the heat source and heat sink are assumed to have infinite heat-capacity rates. The characteristics of the engine are determined when it is operating at maximum power.

WU, Chih, Professor, co-author, "The Optimal Power Performance of an Endoreversible Combined Cycle," *The Journal of the Institute of Energy*, 65,

462 (1992), 41-45.

An optimal-performance analysis of an endoreversible combined cycle (two single endoreversible cycles in a cascade) was carried out, and the maximum power and the efficiency at maximum power for steady-state operation were obtained. These two performance factors, measured against those of a single cycle, can be expressed in terms of two design parameters, and the consequences of varying one parameter were examined in detail. It was shown that as regards efficiency, the combined cycle is superior to the single cycle for all values of that design parameter; and as regards power output, only beyond a certain value of that parameter is the combined cycle superior to the single cycle.

WU, Chih, Professor, "Experimental Data Analysis of a Brine Valve," Division of Engineering and Weapons Report EW-06-92, August 1991.

The experimental design and analysis of a one-inch-brine valve is carried out on the noise level generated by the valve. The design of an experimental plan requires the selection of test points, the order of running each test point, and repeating measurements under identical conditions to estimate the cloud of noise surrounding every test point to assure the desired signal and result. An excellent design plan also includes a minimum number of test runs but most information coverage. The aim of the experiment is to provide definite data on inlet pressure, outlet pressure, and opening position of the valve to support the design and operation of the valve. A statistical analysis provides an estimate of error and enables statistically significant effects to be determined. From these, a curve fitting equation is constructed that defines the noise level in terms of the distribution of the independent operating valve variables. The effects of each of the independent main factors as well as the interaction among the independent factors, are found and ranked in order of importance.

WU, Chih, Professor, "Pressure and Velocity Distributions of a Quieting Element for Gas Throttling Valve Utilizing Porous Plastic," Division of Engineering and Weapons Report EW-05-92, July 1991.

The possibility of controlling noise from a throttling valve by wrapping layers of porous plastic material is proposed. Various designs of the quieting porous material element are given. The pressure and velocity distributions of the element are analytically derived. A computer program of the velocity and pressure distributions is made. Results of the distributions are presented.

WU, Chih, Professor, "Head Losses of an Internal Flow System," Division of Engineering and Weapons Report EW-07-92, August 1991.

The head losses of an internal flow system, which is made of piping, valves, pumps, and other elements, is designed and analyzed to provide a minimum possible noise by the system for shipboard applications.

WU, Chih, Professor, "Specific Power Bound of Real Heat Engines, *Journal of Energy Conversions and Mangement*, 32, 3 (1991), 249-253.

Industrial heat engine optimization usually takes the form of determining minimum heat exchanger area per unit net power or minimum cost per unit net power rather than form of maximum efficiency. A specific power, power per unit total heat exchanger surface area, is adopted to be the objective function for engine optimization in this paper. Specific power output of an irreversible heat engine coupled with its heat source and sink is analyzed. When time is explicitly considered in the energy exchanges between the engine and its surroundings, it is found

that there is an upper bound on the specific power output of the engine. This bound can guide the evaluation of existing real heat engine or influence the design of future heat engines.

WU, Chih, Professor, "Simulation Analysis and Optimization of a Finite-Time Gas Power Plant," *Proceedings of the International Symposium on Computer Applications in Design, Simulation and Analysis*, Orlando, Florida, 11-13 March 1992, pp. 231-234.

The power output of a simple, finite-time closed gas turbine power plant is modelled and analyzed. The model adopted is a reversible Brayton cycle coupled to a heat source and a heat sink by heat transfer. Both the heat source and the heat sink may have either finite or infinite heat capacity rates. A mathematical expression is derived for the power output of the irreversible power plant. The maximum power output of the power plant is found. The maximum bound provides the basis for designing a real closed gas-turbine power plant and for a performance comparison with existing power plants.



## Presentations

JOYCE, James A., Professor, "J-R Curve Evaluation from Predominantly Tensile Specimens Geometries," The 1991 Pressure Vessel and Piping Conference, San Diego, California, 23-27 June 1991.

JOYCE, James A., Professor, "Development of a J-R Curve Initialization Procedure," American Society for Testing Materials Committee Week, San Diego, California, 17 October 1991.

JOYCE, James A., Professor, "Initialization for  $J_{Ic}$  Evaluation," American Society for Testing Materials Working Group Meeting, Annapolis, Maryland, 19 March 1992.

JOYCE, James A., Professor, "Development of the Combined  $J_{Ic}$  J-R Standard," American Society for

Testing Materials Working Group Meeting, Pittsburgh, Pennsylvania, 3-5 May 1992.

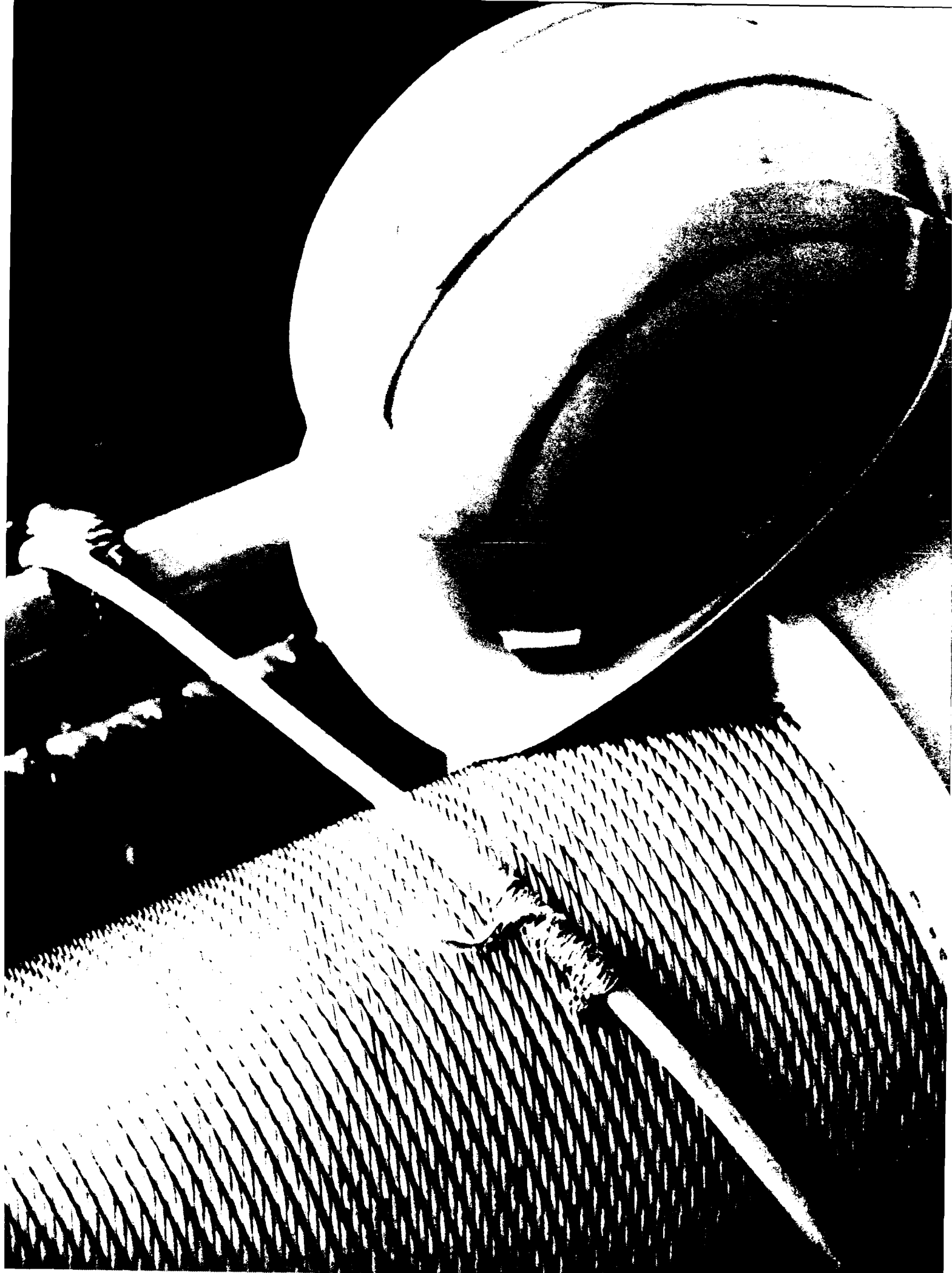
WU, Chih, Professor, "Experimental Design and Analysis of a Brine Valve, Seventh International Congress of Experimental Mechanics, Las Vegas, Nevada, 8-11 June 1992.

WU, Chih, Professor, "Optimum Power Predications for Real Time Combined Cycles," International Conference on Signals and Systems, Geneva, Switzerland, 17-19 June 1992.

WU, Chih, Professor, "Nuclear Powered Gas Turbines," International Conference on Power Systems and Engineering, Vancouver, British Columbia, Canada, 5-7 August 1992.







# Naval Architecture, Ocean, and Marine Engineering

Associate Professor Marshall L. Nuckols  
Chair

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**T**he Naval Architecture, Ocean, and Marine Engineering Department conducted scholarly research and professional development rigorously in all three disciplines of this department during the academic year 1991-1992. Faculty members and midshipmen took part in numerous sponsored research activities, including the Trident Scholar Program. A number of faculty members participated in non-funded research and directed senior midshipmen in their research activities, utilizing the excellent laboratory and computer facilities available to this department.

Particularly noteworthy was the establishment of a five-year Research Chair in Coastal Systems Engineering in this department through sponsorship by the Coastal Systems Station in Panama City, Florida. The principal objective of this chair is to provide a direct relationship between the Coastal Systems Station and the U.S. Naval Academy to conduct research associated with technologies related to diving and salvage, amphibious warfare, special warfare, and mine countermeasures.

The department continued to participate actively in professional society meetings and conferences, both nationally and internationally. Research results have been published in journals and other technical publications or presented at national or international seminars. The outcome of the department's deep involvement in research by the civilian and military faculty members is reflected in the academic environment in the classroom for professional and major courses.

Research themes of the department faculty were varied. They include investigations of nucleate boiling, waves in random seas, neutron dosimetry, beach profile response, drag forces on ships moored in shallow water, Santee Basin pier rehabilitation, subsea cable system design, FFG-7 response to beam wind and waves, reliability-centered maintenance, corrosion and life expectancy of marine structures, and hydrodynamic tests of a



Naval Coastal Systems Command (NCSE) vehicle and a small waterplane area twin hull (SWATH) ship.

Research funding was made available from many sources, including department operating funds, research chairs, and contracts and grants from various research organizations such as the Naval Academy Research Council, the Office of Naval Research, the U.S. Army Corps of Engineers, Naval Facilities Engineering Command, Naval Sea Systems Command, Armed Forces Radiobiology Research Institute, the United States Coast Guard, Coastal Systems Station, the Trident Scholar Program, and Lehigh University.

## **Sponsored Research**

### **Nucleate Boiling in Confined Geometries**

Researcher: Assistant Professor Martin R. Cerza

Sponsor: Naval Academy Research Council (ONR)

In many areas of marine and mechanical engineering, heat transfer plays a significant role in the cooling or heating of various machines or electronic devices. Nucleate boiling is one of the most efficient thermal transport mechanisms. As industry tends to utilize more and more thermal power, the need for efficient cooling becomes more pronounced. The size of these high power density thermal devices is also becoming smaller and smaller; thus, the need to study heat transfer mechanisms applicable to small geometries becomes

apparent.

This investigation is to be accomplished in two phases. The continuation of the first phase is the design and fabrication of a boiling heat transfer loop in which to conduct the basic nucleate microboiling experiments. The second phase is the experimentation and mathematical modeling phase. The design has been achieved in FY91; the fabrication and initial experimentation phase will take a period of one year.

### **Swath Ruddelizer Loading Due to Waves**

Researcher: Professor Roger H. Compton

Sponsor: Naval Sea Systems Command

A unique aspect of a novel new ship type, the Small Waterplane Area Twin Hull (SWATH) ship, is the inclined after control surface used for both steering and vertical motion control called the "ruddelizer." Its novel configuration raises questions about the magnitudes of seaway-induced structural loadings which the ruddelizer is likely to experience. Conventional design practices for rudders and horizontal control surfaces, sail planes, bow planes,

and stern planes for submarines, are related, but not similar enough to use with confidence for SWATH ruddelizer design. A large model of T-AGOS 19 was prepared for testing in irregular waves. An extensive test series involving three sea states, eight ship-to-wave headings, and four ruddelizer deflection angles was undertaken. For all tests, the model was at zero speed and free in all six degrees of freedom.

### **Wave Groups and Breaking Waves in Random Seas**

Researchers: Professor Thomas H. Dawson,

Assistant Professor David L. Kriebel, and

Louise A. Wallendorf, Ocean Engineer

Sponsor: Office of Naval Research

Wave groups and wave breaking in random deep-water seas have been studied experimentally using the Naval Academy's 380-foot wave/towing tank.

Results have been compared with theoretical work that accounts for non-linear effects on crest amplitudes.

## Neutron Dosimetry Research

Researchers: Ensign Richard W. Gordon, USN, and  
Professor Martin E. Nelson

Sponsor: Office of Naval Research

There were three main objectives in performing this study. The first was to gain understanding of different neutron detectors' response to photoneutrons. These data could then be used to develop correction factors for the various devices.

Second was to determine the magnitude of the neutron exposure levels around an accelerator's target area. Lastly, the researcher sought to evaluate the bubble dosimeter as a useful device to measure accelerator produced neutrons.

## Engineering Methods for Predicting Beach Profile Response

Researcher: Assistant Professor David L. Kriebel

Sponsor: U.S. Army Corps of Engineers

The goal of this project is to summarize the state-of-the-art in predicting beach profile response to variations in water level and wave climate. This information is being compiled in the format of an engineering design manual planned for publication by the Army Corps of Engineers for use by their design engineers on shoreline erosion and beach nourishment projects. The methods outlined in this report are generally based on the concept of an equilibrium beach profile, which is defined as a beach cross-section that is in dynamic equilibrium with the water level and incident wave conditions.

Any variation in these conditions, such as sea level rise due to global warming or the storm surge due to hurricane landfall, will necessitate a redistribution of sand across the beach profile, with erosion of sand from the beach face and disposition of sand offshore. Methods presented in this report allow predictions of the extent of this shoreline erosion and address, for example, the landward limit of erosion, the general shape of the beach profile, and the offshore limit of sand deposition in deeper water.

## SUPERTANK Data Collection Project

Researcher: Assistant Professor David L. Kriebel

Sponsors: National Science Foundation and  
U.S. Army Corps of Engineers

The SUPERTANK Data Collection Project, sponsored by the Army Corps of Engineers, was conducted during August and September 1991 at the Wave Research Laboratory of Oregon State University. The goal of the project was to collect data on nearshore waves, current, and sediment transport under controlled conditions at near prototype scale in a large wave tank. Over 30 investigators from the U.S. and several other countries took part in this project. The team from the Naval Academy included Dr. Kriebel from the Ocean Engineering Program, Ms Louise Wallendorf from the Hydromechanics Laboratory, and two midshipmen who participated as part of the Summer Elective Training Program.

The specific research goal of the Naval Academy team was to measure time-series of the water level (wave heights) in the nearshore zone from the region near the still water shoreline up to the upper limit of wave runup. This was accomplished by installing 10 capacitance-based wave sensors in this region. These sensors consisted of a single sensing vertical wire that was partially buried in the sand beach. As waves passed this wire, the water surface was recorded. During the wave run-down, however, the wet sand surface was often exposed and the same sensor was able to record the elevation of the sand surface. As a result, time-series were obtained for both the wave field and for the sand surface at 10 locations across the beach face. From these

data, information may be obtained on several phenomena of interest in coastal engineering and nearshore oceanography including: (1) the statistics of nearshore wave heights, (2) the spatial scales of

wave energy dissipation and decay, and (3) the beach erosion/accretion that occurs over small time scales of one or more individual waves.

### **Drag Forces on Moored Ships in Shallow Water**

Researcher: Assistant Professor David L. Kriebel  
Sponsor: Naval Facilities Engineering Command

Laboratory experiments were performed on two ship models to investigate the variation of steady-current forces in shallow water. The models included an FFG-hull and a Series 60 hull, representative of naval combatants and auxiliary vessels respectively. The testing involved towing small-scale models (1-on-80 scale ratio) in the Naval Academy's 120-foot-long towing tank in order to measure the resulting drag forces in surge and sway, along with the yaw moments that are induced by the fore-aft components of the sway forces. The models were towed at various speeds to simulate steady currents of 1 to 3 knots at full scale. The models were also towed with angles of attack ranging from 0° to 180°, since a current may strike a moored ship from any heading as a result of the ship swinging

about its mooring. The main parameter that was varied from test to test was the water depth in the towing tank. Tests were initially conducted under deep water conditions, where the water depth was about 10 times the ship draft. Under these conditions, the underkeel clearance is sufficient to prevent any interaction between the ship and the sea floor. The after depth was then lowered for subsequent tests. At its lowest, the depth was approximately 1.5 times the ship draft; and at this depth, significant interactions between the hull and the tank bottom were observed. Most important, results indicate that viscous forces on ships moored in shallow water steady currents may be more than two to three times larger than forces at the same current speeds in deep water.

### **Design of a Thermoelectric Heat Pump for Maintaining a Bubble Dosimeter at Constant Temperature**

Researcher: Associate Professor Keith W. Lindler  
Sponsor: Armed Forces Radiobiology Research Institute

The U.S. Navy is currently seeking an accurate and convenient method of measuring neutron radiation. One such method currently being investigated at the U.S. Naval Academy is the bubble dosimeter.

In a bubble dosimeter, radiation induces small droplets of a superheated liquid to grow into a visible bubble. Radiation dose is then determined by counting the number of bubbles formed. Unfortunately, the sensitivity of the bubble dosimeter increases with temperature; thus, in order

to obtain accurate readings, the bubble dosimeter must be maintained at a constant temperature.

A feasibility study has shown that a small battery-powered thermoelectric heat pump could be used to maintain the dosimeter at a near constant temperature for environment temperatures ranging from 0° to 50°C. The current study deals with the design and optimization of the thermoelectric heat pump system.

## **Santee Basin Pier Rehabilitation Project**

Researchers: Associate Professor Robert H. Mayer and  
Professor A. Mohsen Alwan (Mechanical Engineering)  
Sponsor: David Taylor Research Center, Annapolis Laboratory

The design of a floating pier of recycled plastic was completed during the summer of 1991. Personnel of Construction Battalion Unit 403 (CBU-403) fabricated the structure for installation at the Robert Crown Sailing Center as a floating pier for laser sailboats.

The purpose of this design and construction effort was to demonstrate the viability of reconstituting waste plastic from Naval ships and using the recycled plastic in a new and beneficial end-product.

Results indicate that a recycled-plastic floating pier can be both practical and economical. Although a pier of recycled plastic is inherently heavier and costlier than that of its counterpart made of pressure-treated timber, supplemental flotation billets can provide the necessary buoyancy. The anticipated longevity and low maintenance requirements of recycled plastic can result in an economically-competitive structure.

## **Subsea Cable Systems Planning and Design**

Researchers: Associate Professor Robert H. Mayer and  
Professor Michael E. McCormick  
Sponsor: Naval Civil Engineering Laboratory

Among the decisions facing the designer of subsea cable systems are the cable route, cable size and type, method of protection, and the installation plan. Each of these decisions can significantly affect both system cost and reliability. Combined with the uncertainties associated with offshore environmental conditions and man-made hazards, the cable system design is presented a complex decision problem.

Decision theory is a powerful tool for optimizing

the design of systems dealing with uncertainties. This research uses a decision analysis framework which considers all the interdependent cable system design variables and inherent uncertainties "simultaneously." The results are combined with estimates of the costs, benefits, and potential consequences of the various design alternatives, to facilitate selection of the most acceptable cable systems design.

## **Naval Facilities Engineering Command Research Chair**

Researcher: Professor Michael E. McCormick  
Sponsor: Naval Facilities Engineering Command

Research is directed toward two goals: theoretical prediction of iceberg scouring and the prediction of non-linear motions of moored ships. The iceberg

project, which lasted two years, has been completed. The ship-mooring project is now underway.

## **Beam Wind and Wave Experiments on a Model of the FFG-7**

Researcher: Professor Bruce C. Nehrling  
Sponsors: Naval Sea Systems Command and  
David Taylor Research Center, Annapolis Laboratory

A 1:36 scale fiberglass model of a fully appended FFG-7 hull has been built and subdivided into watertight compartments. Mock-ups of the

deckhouse and various topside equipment have also been built.

A wind generation system has been designed and

purchased, along with four trusses to span the 26-foot width of the 380-foot long towing tank. These trusses will provide the framework for mounting up to four high velocity fans.

The model, while dead in the water, will be

subjected to beam winds and waves in an effort to evaluate experimentally the limits of the Navy's standard stability criteria. The model will be tested in an intact condition and while partially flooded.

## Side-By-Side Comparative Model Testing

Researcher: Professor Bruce C. Nehrling

Sponsor: United States Coast Guard

Two patrol craft models, with similar length-to-beam ratios, displacement-to-length ratios, and pitch gyrodii, were instrumented to measure pitch motion, heave motion, and vertical accelerations at three longitudinal locations. One model had hard chines, while the other one had round bilges. Tests were

run at three speeds in both regular and irregular long-crested head seas, with the models arranged side-by-side so that they encountered the waves simultaneously. The seakeeping motions and accelerations of the two models are compared and the merits of side-by-side testing evaluated.

## Coastal Systems Research Chair

Researcher: Associate Professor Marshall L. Nuckols

Coastal Systems Station, Panama City, Florida

A five-year Research Chair was established based on the interest of the U.S. Naval Academy and the Coastal Systems Station, Panama City, Florida, in furthering the understanding and application of technology as it applies to the benefit of the U.S. Navy and the education of its personnel. The principal objective is to provide a direct relationship between the Coastal Systems Station and the U.S.

Naval Academy in the area of Coastal Systems Engineering. It will provide midshipmen and faculty members with exposure to and involvement in research-related activities at the forefront of technologies related to diving and salvage, amphibious warfare, special warfare, and mine countermeasures.

## Reliability-Centered Maintenance

Researcher: Associate Professor Kenneth L. Tuttle

Sponsor: Naval Sea Systems Command

This is a continuing research project to develop faculty expertise and the Marine Propulsion Laboratories at the U.S. Naval Academy for instruction of the midshipmen in modern maintenance engineering concepts. The objectives are as follows: (1) to develop instructional capabilities in maintenance engineering; (2) to introduce RCM, Reliability-Centered Maintenance, to Naval officers; and (3) to develop long-range planning for introducing maintenance engineering into the curriculum.

The Diesel Engine Room Laboratory was upgraded to allow operation of the GM 3-71 diesel engine at four different loads rather than one. Several start-up problems have been solved, and progress is being made toward the addition of significant new engine monitoring capabilities. The Naval Academy has joined the local developer of the Diesel Engine Monitoring and Analysis System in developing further diesel engine monitoring and analysis technology for the U.S. Navy.

## **A Probabilistic Approach for Determining the Effect of Corrosion on the Life Expectancy of Marine Structures**

Researcher: Associate Professor Gregory J. White  
Sponsor: United States Coast Guard

One of the problems in the analysis of marine structures is the effect of exposure to a corrosive environment on strength and survivability. This problem takes two forms; loss of strength due to wastage of the material, and loss of function due to localized pitting penetrating the material. The researcher is seeking to establish a means of quantifying both general wastage and localized pitting of steel plating in a probabilistic format. Wastage rate and pitting rate are treated as random variables in a stochastic process. Initial estimates of both effects are included in the design of a structure, then updated through Bayesian methods

during the lifetime monitoring of the structure.

A method for determination of corrosion from field measurements has been developed on the basis of Semivariogram Analysis and Kriging Estimation. The purpose of using these tools is to provide a sampling strategy for determining the rates to some prescribed level of confidence.

The development of a testing apparatus for the characterization of corroded surfaces has been investigated. Preliminary plans for the device have been developed and the important components purchased.

## **Related to Design Development and Joining Methods for Advanced Producible Hull**

Researcher: Associate Professor Gregory J. White  
Sponsor: Lehigh University

The researcher is participating in the work directed at the technology efforts identified as Design and Development and Joining Methods for Advanced Producible Hull. Specifically within these areas the researcher contributed to the effort on Reliability-Based studies. This includes working on the following: (1) identification of analytical and experi-

mental information needed to define component resistance for reliability-based design of advanced hull structural systems, (2) probabilistic framework for analytical and experimental component resistance evidence, and (3) development of preliminary recommendations for reliability-based design criteria for fatigue.

## **The Behavior and Dissolution of Carbon Dioxide Gas Bubbles in an Ocean Environment**

Researcher: Midshipman 1/C William T. Shaffer, USN  
Adviser: Assistant Professor Martin R. Cerza  
Sponsor: Trident Scholar Program

The purpose of this study is to examine the dissolution characteristics of carbon dioxide gas bubble clouds in water of varying degrees of salinity and under the varying effects of an ocean environment. The dissolution of gas bubbles in water has long been a topic of concern for the Navy. In designing underwater habitats, the dissolution of CO<sub>2</sub> bubbles through a seawater filter is one way to purify the environment air in under-

water environments. There has been extensive work in the literature on the dissolution of single bubbles, but not of bubble clouds. A bubble cloud may possess dissolution characteristics very different from a single bubble. This study experimentally investigated bubble cloud dissolution characteristics under varying parameters that are found in the ocean, such as gas species concentration, bubble-fluid relative velocity, gas flow rates, and salinity.



## **Independent Research**

### **Computer-Aided Hydrodynamic Design**

Researcher: Associate Professor Thomas J. Langan

The purpose of this research is to develop computational methods to assist in the design of floating platforms and ships. This is a long-term

effort, currently concentrating on the development of a cybernetic approach to the problem of hydrodynamic design.

### **Reactants for Deep Submergence Vehicles**

Researcher: Associate Professor Kenneth L. Tuttle

The purpose of this research is to compare reactants that have been identified for use in closed-loop, submerged heat engines. One objective is to indicate problems and advantages associated with each available heat engine; however, the main objective is to show calculated results for thirteen combinations of potential reactants. Eleven different fuels and two different oxidizers were

included. Using an overall thermodynamic efficiency of 26.5 percent, an engine on each fuel produces an average power of about 20 kilowatts for 48 hours on station, plus six hours to descend 6000 meters and six hours to ascend. The tabulated results show the amount of each reactant and size of tank required.

### **Valve Timing--Effects on Power, Torque, and Efficiency**

Researcher: Associate Professor Kenneth L. Tuttle

The timing of the closing of the intake valves on an internal combustion engine is one of the major design variables affecting engine power. The objective of this project was to determine whether an aftermarket high performance camshaft altered

the valve timing from the stock camshaft, and to measure the effects of the changes in valve timing on engine power, torque, and efficiency at both full-load and part-load operation.

### **Hydrodynamic Testing of the Naval Coastal Systems Command Vehicle**

Researchers: John Zselezky, Naval Architect,  
Professor Rameswar Bhattacharyya and  
Associate Professor Marshall L. Nuckols

This project is the first of an extended hydrodynamic test program in which prototype submersible designs are being tested in the 380-foot tow tank facility in the hydromechanics laboratory. In this testing, the "Naval Coastal Systems Center

Vehicle" was tested in upright and rolled 90° positions, with and without fins. Data from these tests were used in the development of a full-scale prototype of the NCSC Vehicle.

## Research Course Projects

### Development of a Circular Wave Basin

Researcher: Midshipman 1/C Holly M. Dobslaw, USN

Adviser: Assistant Professor David L. Kriebel

This project involved the design, construction, and operation of a circular wave basin that will be used for laboratory study of coastal sediment transport and the effect of coastal erosion control structures such as seawalls or groins. The wave basin consists of a circular tank 20 feet in diameter with a sand beach lining the circumference on the inside of the tank walls. The wavemaker consists of a circular cylinder which is rotated about an off-center axis at a constant speed in the center of the circular basin. Due to the eccentric motion of this cylinder, waves spiral outward from the wavemaker and strike the sand beach at an angle, producing longshore movement of the beach sand. Because the beach is

circular, it represents an infinitely long shoreline which has no artificial or abrupt beginning and end.

The first phase of the project was to design and fabricate the so-called "spiral" wavemaker. This required the sizing and procurement of a suitable variable-speed DC motor; design and construction of a wavemaker drive systems; and design and construction of a support frame for the wavemaker. The second phase of the project then included the construction and operation of the circular wave basin. This involved construction of the wave basin out of cinder blocks, placement of beach sand inside the basin, and testing of the performance of the circular wave basin.

### Analysis of Noah's Ark: A Naval Architect's Perspective

Researcher: Midshipman 1/C John P. Fitzgerald, USN

Adviser: Professor Roger H. Compton

Noah's Ark was arguably the first advanced marine vehicle in history, and Noah was the first (and oldest!) naval architect. The statistics on both are mind-boggling. The Ark was only 16 feet shorter, 15 feet wider, and 3 feet deeper than the U.S. Navy's newest destroyer (DDG-51), while Noah was said to have reached the age of 950 years. In this research the design and construction of the Ark was

considered from a twentieth-century naval architectural standpoint; i.e., mission statement, circular of requirements, payload analysis, and at least the beginning of the classic design spiral. While much interesting information was found in the literature and considerable activity continues to quantify the Ark's characteristics, it and Noah remain unsolved mysteries.

### Resistance and Trim of Prismatic Planing Hulls in Calm Water

Researchers: Midshipmen 1/C Lawrence J. Kistler and  
David M. Scott, USN

Adviser: Professor Roger H. Compton

Testing was done on the Naval Sea Systems Command deadrise series planing hullforms to measure their resistance and running trim angle at varying speeds in calm water. Laboratory testing was done in the Naval Academy Hydromechanics Laboratory's 380-foot tow tank.

The first phase consisted of completing the series by testing the 25-degree model at its design

displacement. Data runs at speeds varying from 5 to 22 feet per second (fps) were conducted on the models. Sample runs of the previously tested 15 and 20 degree models were done to check consistency in the readings of the wetted lengths on the model's chine and keel. Next, tests were done on the 15- and 25-degree models with each model ballasted to the 20-degree model's design

displacement to study performance at a constant loading.

The second phase was the compilation and analysis of the test results. The resistance and trim result of the 15-, 20- and 25-degree models at varying speeds were plotted to show the effects of deadrise angle. Likewise, the resistance and trim of the three hullforms at a common displacement were plotted to show the effects of deadrise on commonly displaced boats. Finally, the data from the individual hulls were compared to results predicted

using the Savitsky and Savitsky-Ward Brown methods.

Results indicate, as expected, that at constant speed and displacement, boats with a low deadrise angle require less horsepower than similar boats with greater deadrise. Results also indicate that the analytical methods currently used drastically overpredict running trim angles, while underestimating the boats' effective horsepower (EHP) at the higher speeds studied.

## **Testing of a Prototype Thermoelectric Heat Pump for Maintaining a Bubble Dosimeter at Constant Temperature**

Researcher: Midshipman 1/C Keith M. Kitagawa, USN

Adviser: Associate Professor Keith W. Lindler

A small battery-powered prototype thermoelectric heat pump was designed and built for use in maintaining a bubble dosimeter at near constant temperatures for varying ambient temperatures. Performance tests conducted with this prototype heat pump were used to validate a computer spreadsheet model that was developed to simulate

the heat pump performance. The computer model and prototype were then used to optimize system performance by proper selection of the battery voltage and control strategy for various ambient conditions. This research was sponsored by the Armed Forces Radiobiology Research Institute.

## **Applied Computer Methods in Ship Hydrostatics and Stability**

Researcher: Midshipman 1/C Dirk H. Renick, USN

Adviser: Professor Rameswar Bhattacharyya

Many of the current methods employed in ship hydrostatics and stability are mathematically not rigorous enough. The formulas employed, which are approximations of their mathematical basis, may result in inadequate results. By using a computer, which can quickly perform long, intensive calculations, the naval architect can remove many of the approximations used in hand calculations.

The purpose of this project was first to present

many of the current mathematical theories on ship hydrostatics and stability; these theories then were transformed into logical algorithms; and finally, the algorithms provided the basis for a computer code. The computer code was tested on a Series 60 hullform, and the results of the computer code were compared to existing data from the current approach to ship hydrostatics and stability.

## **Open Water Propeller Testing in Inclined Flows**

Researcher: Midshipman 1/C Dirk H. Renick, USN

Adviser: Professor Roger H. Compton

Few propellers have the luxury of acting in purely axial flow conditions, yet traditional open water propeller testing is performed with the propeller disk perpendicular to a uniform flow field. An experimental apparatus was designed and built to permit propellers to be tested, using the Naval Academy Hydromechanics Laboratory propeller

boat, at shaft angles of up to 12° to the flow velocity. An existing three-bladed YP propeller model was tested at four shaft angles (including zero) and the result compared by means of the resulting open water propeller diagrams. Differences in (axial) thrust produced, and torque absorbed were minimal over the conditions tested.

## **Analysis of Racing Oar Blades' Mechanics**

Researcher: Midshipman 1/C David T. Schroder, USN

Adviser: Professor Roger H. Compton

Laboratory experiments were conducted on a conventional racing oar to investigate the mechanics associated with the oar and its blade in particular. With the development of a test platform and matrix, a conventional blade shape was compared to a new and radically different racing blade shape.

The first phase of this study involved investigating the governing rules for racing oars, developing a logical nomenclature for an oar blade, designing and fabricating a test platform on which a rower would provide propulsive power, and performing an initial series of tests to evaluate methodology.

The second phase consisted of improving the experimental apparatus and rerunning the initial tests. Using the force data provided by the improved test platform, force time histories were used to analyze the mechanical motion of the oar. Having recorded values of forces imparted to a shell

by an oar, the researcher could check both the validity of existing theory on blade dynamics and the reasonableness of this project's data.

The final phase of the testing addressed the comparison of the traditional racing blade shape to a very new and different shape. Four test runs were performed for each blade at a test platform speed of 18 feet-per-second. Most of the results are subjective in nature. The larger blade, asymmetric in shape, provided a smoother, firmer feel in the water, and its force plots reflected this reaction. The larger blade also provided larger values of power over a given stroke. Rowing with the larger blade suggests that it may be better adapted to the flow that takes place around the oar, and that its larger surface area may not require a larger force from the rower.

## **Model Testing of a Vertical Wave Barrier**

Researcher: Midshipman 1/C Eric M. Thomas, USN

Adviser: Assistant Professor David L. Kriebel

This project involved laboratory testing of a vertical wave barrier, sometimes called a vertical breakwater, baffle breakwater, or wave screen. The vertical wave barrier tested here consists of a permeable vertical wall that may extend over the full water depth or down to mid-depth. The structure consists of a series of vertical boards separated by vertical gaps. The gaps in the wall, along with the space at the bottom of the wall, are environmentally beneficial, since they allow some natural circulation of water under and through the structure. Also, the wave forces on a permeable wall are less than those that would occur on a solid impermeable wall. However, the permeable wave barrier also allows some percentage of the incident wave energy to pass through the structure and into the protected harbor behind the breakwater. For design, there is an obvious trade-off between larger gaps, which improve circulation and which reduce the wave forces on the wall, and smaller gaps which reduce the size of the transmitted waves.

The purpose of this study was to augment model tests conducted in a previous project in order to document more completely both the wave transmission and wave force characteristics of the vertical wave barrier. Model tests were conducted in the 120-foot-long wave tank located in the Hydromechanics Laboratory in Rickover Hall. The wave barrier was constructed of 3-inch wide boards mounted to an aluminum frame which spanned the 8-foot wide wave tank. The boards were adjustable so that several gap spacings could be tested by simply sliding boards laterally. Tests were conducted for two wall depths and for two gap spacings. Regular waves were used in all tests. Measurements included the incident, reflected, and transmitted wave heights, as well as wave forces on one instrumented vertical board. Results of this and other studies provide design engineers with the necessary information concerning the behavior of wave forces on and wave transmission through these vertical wave barriers.

## Bi-Directional Radial Wave Energy Turbine

Researcher: Midshipman 1/C Bryan D. Williams, USN

Adviser: Professor Michael E. McCormick

Both wind-tunnel and wave tank tests were performed on a single-rotor radial turbine, capable of operating in a bi-directional wind mode. The performance characteristics were established in the wind-tunnel tests, while the performance in waves was determined from wave tank tests.

To obtain high rpm's for the generator, a pulley drive was designed and built. Unfortunately, the

starting torque was too large for the wave-induced air motions, since the wave heights were limited due to a malfunction in the wave-maker.

The system did produce electricity in waves. Furthermore, the wind-tunnel tests show that the overall efficiency of the system (busbar efficiency) is approximately 70% in steady air flow.

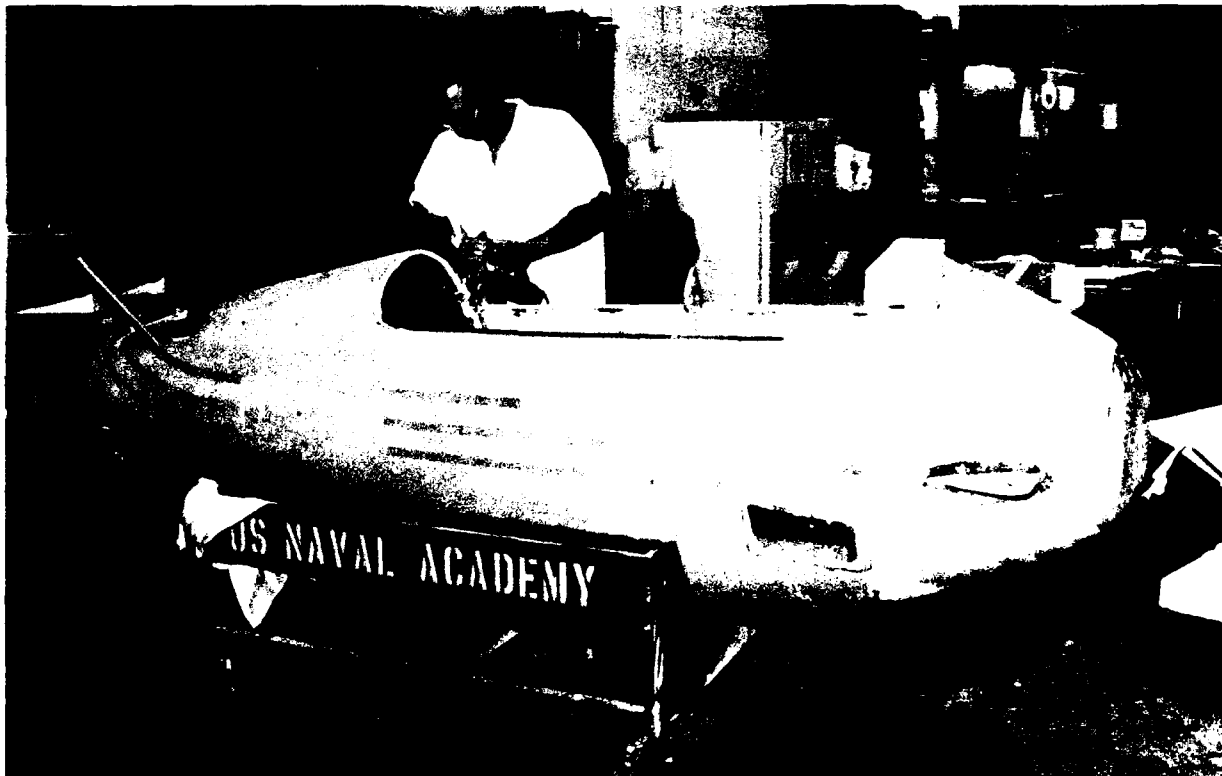
## Computer-Aided Design of Submersibles

Researcher: Midshipman 1/C Kevin G. Williams, USN

Adviser: Professor Rameswar Bhattacharyya

The objective of this project was to design a research submersible for ocean engineering applications with the aid of a computer. A specific mission for the submersible was clarified along with the design criteria necessary for that mission. De-

Design calculations were performed for any hullform within the design limits. Economic considerations were applied to optimize submersible design with cost. Finally, the hullform was determined and put into graphic applications.



## Publications

DAWSON, Thomas H., Professor, and David L. KRIEBEL, Assistant Professor, "Breaking Waves in Deep-Water Random Seas," *Proceedings of First International Offshore and Polar Engineering Conference*, Edinburgh, Scotland, August 1991, pp. 39-46.

Results from a laboratory study of wave breaking in deep-water random seas are presented for approximate JONSWAP sea states. Waves generated at one end of a 116-meter wave tank are observed for breaking at a section of the tank approximately 30 meters from the wave maker and in regions spanning 3 and 6 meters about it. Emphasis is on the relative number of breaking waves observed at the section and in the regions about it, and on the distribution of crest amplitudes observed at the section. Measurements at the section are compared with predictions from a breaking criterion and modified Rayleigh distribution of crest amplitudes that accounts approximately for non-linear effects in seas with narrow-banded wave frequencies. Active breaking is found to occur when the downward crest acceleration, based on mean wave frequency, equals about one-third the acceleration of gravity. The measured distribution of crest amplitudes in the breaking sea state is found to agree approximately with lower-bound calculations based on the assumption that all breaking waves collapse instantaneously to their equilibrium level. Experimental measurements of breaking in regions about the section are shown to be in good agreement with theoretical predictions relating breaking events over a region to those at a fixed location.

DAWSON, Thomas H., Professor, David L. KRIEBEL, Assistant Professor, and Ms Louise WALLENDORF, Ocean Engineer, "Experimental Study of Wave Groups in Deep-Water Random Waves," *Journal of Applied Ocean Research*, 13, 3 (1991), 116-131.

Results from a laboratory study of wave groups in random seas are presented for Bretschneider and JONSWAP sea states. A distinction is made between general crest-envelope crossings of a threshold level and those involving groups of two or more wave crests. Measurements show that the average duration of a run of high waves in groups and the average interval between such groups are significantly greater than the values found for general envelope crossings, since many large waves

occur by themselves and not in groups. Experimental results for these average values, as well as for probability density functions of time durations and intervals, are found to be characterized broadly by linear similarity relationships, with non-linear effects of enhanced crest amplitudes altering this similarity at high threshold levels.

Average envelope durations and intervals are then shown to be consistent with standard envelope theory of random waves when used with parameters derived from truncated amplitude spectra and non-linear crest statistics. Probability density distributions for envelope durations and intervals are shown to be described approximately by Gamma functions rather than the commonly assumed exponential function. Average durations and intervals for groups of two or more wave crests, as well as their associated probability density functions, are also shown to be theoretically related to the corresponding envelope statistics.

JOHNSON, Bruce, Professor, co-author, "A Review of Expert Systems for Marine Design and Ship Operations," *Proceedings of the World Congress on Expert Systems*, Orlando, Florida, 16-19 December 1991, pp. 3055-3063.

Marine design refers to many aspects of designing ships and structures for operation in the marine environment. For example, the conceptual design of ship hullforms involves investigating the effects of hull geometry variations on hydrodynamic performance characteristics in still water and in waves. On the other hand, ocean structures are designed to withstand severe wave conditions, so the resistance in still water is of little importance. Ship operations refer to all aspects of ocean shipping, including cargo handling, piloting and routing, machinery operation, and maintenance, etc. The application of artificial intelligence techniques and ideas has so far been more common in ship operations than in ship design. Most of the work done in computer-aided ship design has been on the analysis and evaluation of candidate design. Expert systems have been used very little to provide high-level intellectual assistance to the generating of possible design solutions and to control the design process. Some attempts to develop integrated CAD systems for ship design and construction are underway, and artificial intelligence methods are seriously being considered in several of these projects.

KRIEBEL, David L., Assistant Professor, "Nonlinear Wave Interaction with a Vertical Circular Cylinder, Part II: Wave Run-up," *Ocean Engineering Journal*, 19, 1 (1992), 75-99.

Theoretical results for second-order wave run-up around a large diameter vertical circular cylinder are compared to results of 22 laboratory experiments conducted in regular nonlinear waves. In general, the second-order theory explains a significant portion of the nonlinear wave run-up distribution measured at all angles around the cylinder. At the front of the cylinder, for example, measured maximum run-up exceeds linear theory by 44% on average but exceeds the nonlinear theory by only 11% on average. In some cases, both measured run-up and the second-order theory exceed the linear prediction by more than 50%. Similar results are found at the rear of the cylinder, where the second-order theory predicts a large increase in wave amplitude for cases where the linear diffraction theory predicts little or no increase. Overall, the nonlinear diffraction theory is found to be valid for the same relative depth and wave steepness conditions applicable to Stokes second-order plane-wave theory. In the last section of the paper, design curves are presented for estimating the maximum second-order wave run-up for a wide range of conditions in terms of the relative depth, relative cylinder size, and wave steepness.

KRIEBEL, David L., Assistant Professor, co-author, "Engineering Methods for Predicting Beach Profile Response," *Proceedings of the Coastal Sediments '91 Conference*, Seattle, Washington, 25 June 1991, pp. 557-571.

This paper contains a review of so-called "engineering methods" for predicting beach profile change based on equilibrium profile concepts. In the first part of the paper, three equilibrium profile forms are discussed, including two that account for realistic beach-face slopes. In the second part of the paper, these profile forms are used to obtain analytical solutions for the maximum erosion potential in response to a water level rise. These solutions assume that the water level is maintained steady until the profile reaches its full equilibrium response, which is not realistic. Therefore, the final part of the paper presents a new method for incorporating time-dependent erosion effects based on a convolution integral.

KRIEBEL, David L., Assistant Professor, co-author, "Evaluation of Beach Erosion and Accretion Predictors," *Proceedings of the Coastal Sediments '91 Conference*, Seattle, Washington, 25 June 1991, pp. 572-587.

This paper examines the capability of simple criteria to predict whether a beach will erode or accrete by wave-induced cross-shore sand transport. Emphasis is on beach change of engineering interest such as associated with storm erosion, poststorm recovery, and seasonal wave conditions. The criteria, originally developed based on data from small and large tanks and monochromatic waves, correctly predict most erosion and accretion events in a newly compiled field data set encompassing beaches around the world. Previous studies that found such criteria unsuccessful are reviewed and found to be questionable. Correspondence between events in the field with random waves and in large wave tanks with monochromatic waves is obtained if mean wave height is used in field applications; however, any statistical wave height can be used by adjustment of one empirical coefficient in each criterion. Two dimensionless parameters (fall speed parameter and a newly-introduced Froude number) used in some criteria are shown to be related to a critical wave energy dissipation needed to suspend sediment.

KRIEBEL, David L., Assistant Professor, and Thomas H. DAWSON, Professor, "Distribution of Crest Amplitudes in Severe Seas with Breaking," *Proceedings of the Eleventh International Conference on Offshore Mechanics and Arctic Engineering*, Calgary, Alberta, Canada, 8 June 1992, pp. 43-50.

A theoretical description is presented for the probability distribution of wave crest amplitudes in severe seas states with wave breaking. As is well-known, the Rayleigh distribution provides an acceptable description of wave amplitudes as long as the sea state is not too severe such that individual waves are described reasonably-well by linear theory. As the severity of the sea state increases, however, wave nonlinearity causes the distribution of crest amplitudes to deviate from linear theory, with an appreciable increase in the amplitudes of the largest wave crests. In the present paper, a theory for the probabilities of these nonlinear crest amplitudes is first reviewed based on earlier work. The further modification of these nonlinear crest amplitudes by wave breaking and subsequent collapsing of the breaking waves is then considered. As a result, a theoretical model is presented to account for the two important modifications to crest amplitudes in the most severe seas: (1) the nonlinear increase in the highest wave crests, and (2) the selective reduction of some fraction of these high crests due to wave breaking. This model is then evaluated using several sets of laboratory data for severe breaking seas having approximate JONSWAP wave spectra.

LINDLER, Keith W., Associate Professor, "Maintaining Bubble Dosimeters at Constant Temperature by Use of a Thermoelectric Heat Pump," *Proceedings of the Twenty-sixth Intersociety Energy Conversion Engineering Conference*, Boston, Massachusetts, 4-9 August 1991, Vol. 2, pp. 534-539.

The U.S. Navy is currently seeking an accurate and convenient method of measuring neutron radiation. One such method currently being investigated at the U.S. Naval Academy is the bubble dosimeter. In a bubble dosimeter, radiation induces small droplets of a superheated liquid to grow into a visible bubble. Radiation dose is then determined by counting the number of bubbles formed. Unfortunately, the sensitivity of the bubble dosimeter increases with temperature. Thus in order to obtain accurate readings, the bubble dosimeter must be maintained at a constant temperature. Four methods of compensating for the temperature dependence of the bubble dosimeter were investigated. The most promising method is a small thermoelectric heat pump which would be used to maintain the bubble dosimeter at a constant temperature. This paper presents the results of a preliminary study that was undertaken to determine the feasibility of using a thermoelectric heat pump for this application.

MAYER, Robert H. Jr., Associate Professor, co-author, "Design and Construction Plan for a Floating Pier of Recycled Plastic," Division of Engineering and Weapons Report EW-17-91, March 1992.

The purpose of this design and construction effort was to demonstrate the viability of reconstituting waste plastic from Naval ships and using the recycled plastic for a new and beneficial end-product. Results indicate that a recycled-plastic floating pier can be made both practical and economical. Although a pier of recycled plastic is inherently heavier and costlier than its counterpart made of pressure-treated timber, supplemental floatation billets can provide the necessary buoyancy. The anticipated longevity and low maintenance requirements of recycled plastic can result in an economically-competitive structure.

MCCORMICK, Michael E., Professor, co-author, "Positive Drift of a Backward-Bent Duct Barge," *Journal of Waterway, Port, Coastal and Ocean Engineers*, 118, 1, (Jan/Feb 1992), 106-111.

This very interesting phenomenon of forward drift is due to a basic fluid dynamical behavior of an

oscillating water column in a 90° bend. There is some internal "free-surface effect" or "sloshing"; however, the dominant mechanism causing the positive drift is the momentum transfer from the oscillating water column to the bow, since the internal free-surface area is relatively small. The frequency range over which the phenomenon occurs is rather broad. A future advantage of the forward drift might be found in motion control of a broached ship. In addition, since the floating body has a tendency to drift in the positive direction, the backward-bent duct could have a future in reducing mooring loads on floating vessels.

MCCORMICK, Michael E., Professor, "A Theoretical Analysis of a Self-Propelled Backward-Bent Duct Wave Energy Conversion System," *Journal of Energy Resources Technology*, 113, (June 1991), 94-100.

An analysis of a self-propelled Backward-Bent Duct Barge (BBDB) wave energy conversion system operating at an averaged forward speed is presented. The energy required to propel the system is a parasitic energy of the wave energy conversion subsystem. The analysis includes a feedback between the internal water motions and the floating body dynamics. The performance of the BBDB operating in a design (head) sea is shown to be far superior to both a BBDB in a following sea and a fixed BBDB in a following sea.

MCCORMICK, Michael E., Professor, "An Experimental Study of a Backward Bent Duct Barge Wave Energy Conversion System," *Proceedings of the Marine Technology Society, "MTS '91,"* New Orleans, Louisiana, Paper 157, November 1991.

Results of an experimental study of a 1/20th scale model of a Backward-Bent Duct Barge (BBDB) wave energy conversion system show the effects of both restricted waters and mass distribution on the performance of the system. Measurements of the heaving and pitching of the 1.78-meter model, taken simultaneously with those of the motions of the internal water column, show a strong coupling between the motions. The water column motions measured are those relative to the floating system, since the energy conversion depends on this relative motion. The power of the water column is compared to the incident wave power in this two-dimensional study, and the resulting peak conversion efficiency is found to be more than 90%. Finally, the floating system is shown to have a positive drift over a frequency range that depends on both the water depth and the mass distribution.



MCCORMICK, Michael E., Professor, and Robert H. MAYER, Associate Professor, "On the Probabilities Associated with Iceberg Scour in the Coastal Zone," Division of Engineering and Weapons Report EW-15-91, August 1991.

In order to improve the decision-making process for the placement of line structures (pipelines and cables) in ice-infested coastal waters, the spacial and temporal probabilities of iceberg scour are established. The formulae for these statistical quantities are modeled after field data obtained in a number of locations in the waters adjacent to the northern border of the North American Continent. It is believed that the formulae well-described the general statistical behaviors of grounding icebergs. The formulae can be applied to any one site during one of the winter-spring months, provided that the various occurrence rates are known or can be estimated throughout the period of interest.

The probabilities formulated are those for the spacial gouge distributions, the temporal iceberg passage in coastal waters, the spacial distributions of the iceberg keel, the "diameter" of the iceberg, the drift velocity, and the iceberg mass. The first of these is useful in the construction-stage planning. The second provides the likelihood of iceberg occurrence. The remaining statistical quantities are needed to analyze the ice-seabed interactions.

MCCORMICK, Michael E., Professor, co-author, "Large-Scale Experimental Study of the McCabe Wave Pump," Division of Engineering and Weapons Report EW-03-92, January 1992.

An experimental study of a single pontoon coupled to a hydraulic system used in a McCabe Wave Pump (MWP) wave energy conversion system was conducted in the 117-meter wave tank at the U.S. Naval Academy. The wave-induced pontoon motions excited the closed-circuit hydraulic system in which oil was the working fluid. The power output of the hydraulic system was determined from simultaneous measurements of the oil flow rate and the operating pressure in the system. The results show that the overall efficiency of the system increases with wave period over the experimental study range. The maximum efficiency, based on the wave power incident on the bow of the pontoon, is approximately 160%. Since this value well exceeds 100%, the phenomenon of diffractive wave focusing is demonstrated. By scaling the experimental results to a 14m x 10m prototype pontoon operating in a

1.5-meter, 6-second sea, it is shown that the prototype lead-pontoon and hydraulic system will produce approximately 171 kW when operating at the maximum efficiency condition. Furthermore, the two-pontoon MWP system will generate 273 kW of hydraulic power when operating in the same waves.

MCCORMICK, Michael E., Professor, co-author, "Decision Theory Modeling of Iceberg Dynamics," Division of Engineering and Weapons Report, EW-12-92, June 1992.

Presented in this paper are the results from the numerical part of a study on iceberg dynamics in the sub-Arctic coastal zone. This work follows two earlier papers by McCormick and Mayer--the first presenting an overview of the aspects of decision analysis applied to subsea line structures and the second on the probabilities associated with different iceberg features. The objective of this part of the study is the formulation of a computer program that may be used by a systems designer/decision maker as a design aid. The program utilizes user-defined system and cost parameters and simulates the structure-iceberg interaction process over the design life of the structure, thereby arriving at an estimate of the total project cost. The decision maker can use these results to compare and choose from among several design alternatives. A numerical example of a segmented line structure laid off the shores of the S. Beaufort Sea is solved, and the results corresponding to several routing and burial options are presented.

NEHRLING, Bruce C., Professor, co-author, "Side-By-Side Testing of Hard Chine and Round Bilge Semi-planing Models in Waves," *Proceedings of the High Performance Marine Vehicle Conference (HPMV'92)*, June 1992, pp. PC60-PC71.

Two patrol craft models, with similar length-to-beam ratios, displacement-to-length ratios, and pitch gyrodii, were instrumented to measure pitch motion, heave motion, and vertical accelerations at three longitudinal locations. One model had hard chines, while the other one had round bilges. Tests were run at three speeds in both regular and irregular long-crested head seas, with the models arranged side-by-side, so that they encountered the waves simultaneously. The seakeeping motions and accelerations of the two models are compared, and the merits of side-by-side testing are discussed.

NELSON, Martin E., Professor, "Comparison of Neutron Measurements at LINACs Using Bubble Neutron Dosimeters to Other Neutron Detectors," Division of Engineering and Weapons Report, EW-09-92, May 1992.

The purpose of this report is to present results obtained from different neutron dosimetry devices when used to measure neutron production at two different electron linear accelerators. The dosimetry devices used included thermoluminescent detectors (TLD), track-etch devices (CR-39), bubble dosimeters, and neutron activation foils. The devices were placed at different locations around each accelerator's beam axis in order to gain understanding of the neutron spatial distribution. Multiple tests were performed with the accelerators at different rad outputs, so that each device would be exposed to a neutron dose which would fall in the device's dynamic range. The accelerators studied were located at Centennial Medical Center (CMC) in Nashville, Tennessee, and Naval Weapons Support Center (NWSC) in Crane, Indiana. The CMC accelerator produced a maximum beam energy of 20 MeV, while the NWSC accelerators could produce a 40 MeV beam.

NUCKOLS, Marshall L., Associate Professor, "Preparing for our Future Ocean Presence--Ocean Engineering at the U.S. Naval Academy," *Journal of Marine Technology Society*, 26, 1 (Spring 1992), 14-21.

The ocean engineering curriculum at the U.S. Naval Academy provides our future Naval officers with a rigorous engineering program that uniquely qualifies them to meet the technical challenges created by the sea environment. Coupled with an intensive regimen of professional training in the classroom and at sea, the Naval Academy midshipmen are faced with a challenge that few college students will ever face. Although the program is designed specifically for developing future Naval officers, the basic approach is valid for any engineering school. The discipline, leadership training, and academic foundation that they receive prepare them for a lifetime of challenges in the inevitable resurgence of national interest in deep ocean technology.

NUCKOLS, Marshall L., Associate Professor, "Midshipman Elective Laboratory Training Program, 1991: Naval Coastal Systems Center," Division of Engineering and Weapons Report EW-16-91, September 1991.

During the 1991 summer intersessional period, seven 1/C midshipmen spent a 4-6 week period at the Naval Coastal Systems Center in Panama City, Florida to participate in ongoing research and development projects. The intent of the Laboratory

Training Program is to allow midshipmen to apply their academic training and to enhance their awareness of the development and application of new technology for defense support.

This report consolidates the individual midshipmen research reports submitted following their temporary duty at the Naval Coastal Systems Center, Panama City, Florida.

TUTTLE, Kenneth, L., Associate Professor, "Reactants for Deep Submergence Vehicles," *Ocean Engineering*, Manuscript N. 897, 1991.

The purpose of this research is to compare reactants that have been identified for use in closed-loop, submerged heat engines. One objective is to indicate problems and advantages associated with each available heat engine; however, the main objective is to show calculated results for thirteen combinations of potential reactants. Eleven different fuels and two different oxidizers were included. Using an overall thermodynamic efficiency of 26.5 percent, an engine on each fuel produces an average power of about 20 kilowatts for 48 hours on station, plus six hours to descend 6000 meters and six hours to ascend. The tabulated results show the amount of each reactant and size of tank required. The chemical assumptions and constants used for the calculations have been provided to permit verification of the results.

TUTTLE, Kenneth L., Associate Professor, "The Second International Submarine Races," *Proceedings of the American Society for Engineering Education Annual Conference*, New Orleans, Louisiana, June 1991, pp. 1413-1415.

Human-powered submarines raced for the second year in Riviera Beach, Florida, 15-23 June 1991, and were open to all comers. There was a special category for student entries; however, last time a student entry won it all. This report is an overview of the contest, as well as a historical documentation of past results. The Ocean and Marine Engineering Division of the American Society for Engineering Education is sponsoring an award for student entries.

TUTTLE, Kenneth L., Associate Professor, "Reducing Gas Turbine Duct Sizes at Main Deck Penetration: Progress Report on Beneficial Suggestion 85-34," Division of Engineering and Weapons Report EW-16-92, February 1992.

Higher gas velocities and smaller ducts are possible without incurring unacceptable pressure losses. The size of the holes required for the intake and exhaust ducts to penetrate the main deck on U.S. Navy ships has always been a cause of concern because of the degradation of this important strength member.

The concept being presented is a design for gas turbine intake and exhaust ducts that will permit smaller cuts in the main deck. The proposed design is shown superimposed on the drawings of the DD963 forward engine room. A well-rounded inlet is used in the transition section of the duct in place of the tapered transition. In addition, the size of the duct is reduced prior to its penetration of the main deck. The limiting size in the intake duct remains the size needed for engine removal. The exhaust is expanded to its existing size at the silencer; however, the intake duct can retain its reduced size for the short run to the module. Pressure loss calculations compare the existing with the proposed design.

WHITE, Gregory J., Associate Professor, co-author, "A Probabilistic-Based Methodology for Including Corrosion in the Structural Life Assessment of Marine Structures," Division of Engineering and Weapons Report, EW-04-92, February 1992.

An approach for determining the mean value of thickness and the mean or percentile depth of the extreme pit of corroded steel plating is suggested. The approach is based on the concepts of semivariogram analysis with Kriging estimation and extreme value statistics. The probabilistic nature of the results comes from treating the plate thickness measured at any point as a random variable and investigating the uncertainties associated with determining the mean value of thickness. The effects of time and errors in the measuring device are considered. The results of the procedure are an estimated mean value of thickness with confidence intervals and an estimate for the extreme pit depth which has the user specified probability of occurrence.

A proposed experimental program for determining the statistical parameters needed for the semivariogram procedures is described. The

parameters are calculated from thickness measurements taken at small intervals over sample specimens of material. These specimens will have experienced a corrosive environment of a certain kind for a specified length of time. The measurements will be used to calculate the characteristic parameters called the sill and the range of influence. The effect of levels of corrosion, time, and material type on these parameters will be observed. To facilitate taking this large number of thickness measurements, a "Corrosion Measurement Rig" has been designed. Finally, a simple-to-use computer program has been developed to perform the analysis described in this report. The program is written using Microsoft Visual Basic and runs in the Windows 3.x environment. The program is capable of being run on a suitably equipped "notebook" computer for use in the field.

WHITE, Gregory J., Associate Professor, "Determining the Effects of Corrosion on Steel Structures: A Probabilistic Approach," *Proceedings of the Offshore Mechanics and Arctic Engineering (OMAE '92) Conference*, Calgary, Alberta, Canada, 7-11 June 1992, pp. 111-121.

An approach for determining the mean value of thickness and the mean or percentile depth of the extreme pit of corroded steel plating is suggested. The approach is based on the concepts of semivariogram analysis with Kriging estimation and extreme value statistics. The probabilistic nature of the results comes from treating the plate thickness at any point as a random variable and investigating the uncertainties associated with determining the mean value of thickness. The effects of time and errors in the measuring device are considered. The results of the procedure are an estimated mean value of thickness with confidence intervals and an estimate for the extreme pit depth which has the user specified probability of occurrence.

## Presentations

CERZA, Martin R., Assistant Professor, "Nucleate Boiling in Thin, Falling Liquid Films," Pool and External Flow Boiling Conference, The Engineering Foundation, Santa Barbara, California, 22-27 March 1992.

HARPER, Mark J., Assistant Professor, and Martin E. NELSON, Professor, "Bubble Dosimeter Applications for Treaty Verification Purposes," Defense Nuclear Agency Colloquium, Springfield, Virginia, 14 February 1992.

JOHNSON, Bruce, Professor, "On the Role of Expert Systems in the Design Spiral of Ships," The World Congress on Expert Systems, Orlando, Florida, 16-19 December 1991.

KRIEBEL, David L., Assistant Professor, "Dune Erosion Model Based on Energy Dissipation Concepts," Workshop on Development and Applications of Cross-Shore Sediment Transport and Beach Profile Change Models, Coastal Sediments Conference, Seattle, Washington, 24 June 1991.

KRIEBEL, David L., Assistant Professor, "Engineering Methods for Predicting Beach Profile Response," Coastal Sediments Conference, Seattle, Washington, 25 June 1991.

KRIEBEL, David L., Assistant Professor, "Distribution of Crest Amplitudes in Severe Seas with Breaking," International Conference on Offshore Mechanics and Arctic Engineering, Calgary, Alberta, Canada, 7-11 June 1992.

LANGAN, Thomas J., Associate Professor, "Computer-Aided Synthesis in Design, A Cybernetic View," Department of Civil Engineering Seminar, Johns Hopkins University, Baltimore, Maryland, 29 October 1991.

LINDLER, Keith, W., Associate Professor, "Maintaining Bubble Dosimeters at Constant Temperature by Use of a Thermoelectric Heat Pump," Twenty-sixth Intersociety Energy Conversion Engineering Conference, Boston, Massachusetts, 4-9 August 1991.

TUTTLE, Kenneth L., Associate Professor, "The Second International Submarine Races," American Society for Engineering Education, Annual Conference, New Orleans, Louisiana, 18 June 1991.

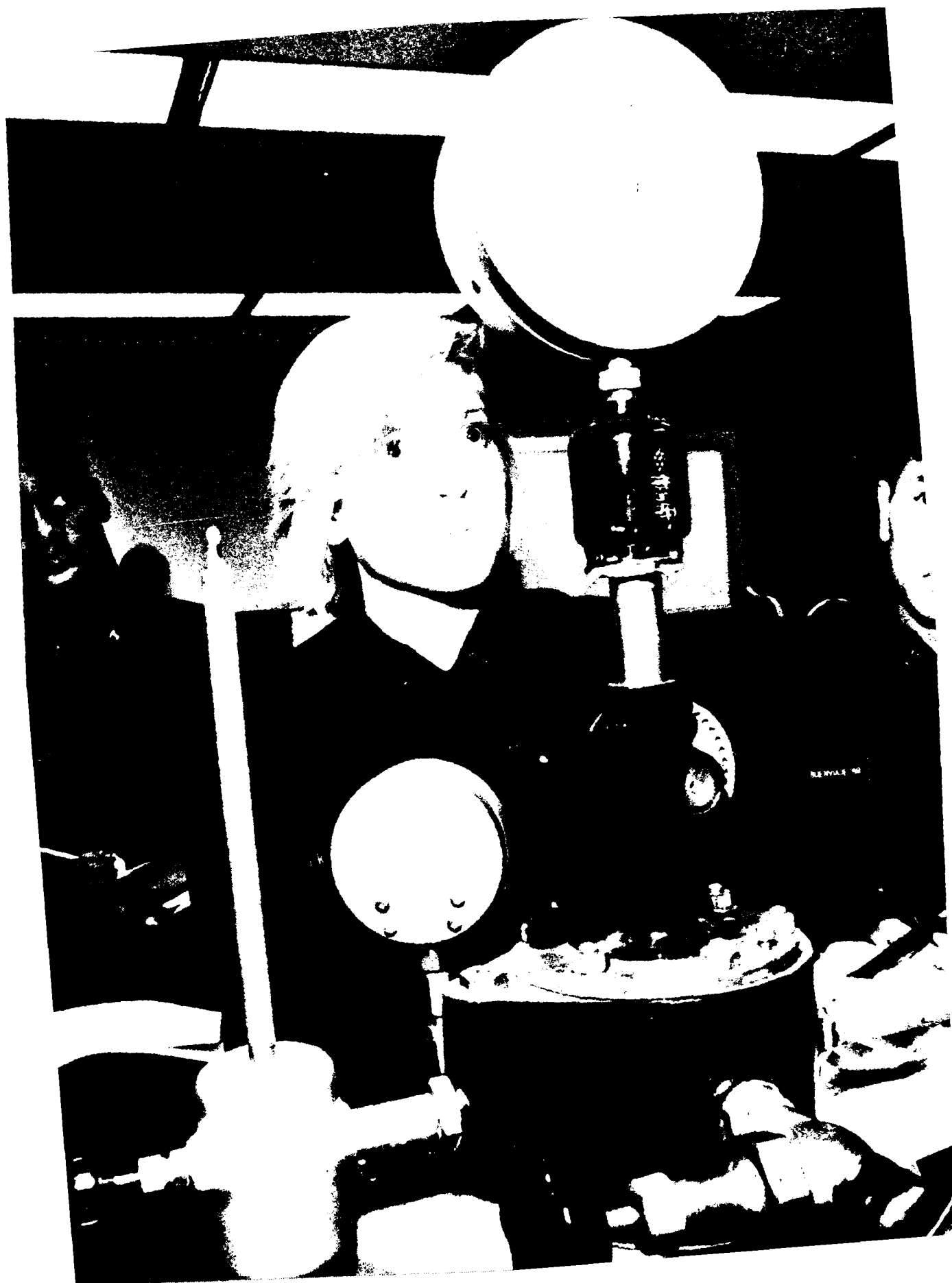
WHITE, Gregory J., Associate Professor, "Naval Ship Design: A Structural Designer's Perspective," Center for Advanced Technology for Large Structural Systems Seminar, Lehigh University, Bethlehem, Pennsylvania, 15 October 1991.

WHITE, Gregory J., Associate Professor, "Naval Ship Design: Loadings on a Ship's Structure," Center for Advanced Technology for Large Structural Systems Seminar, Lehigh University, Bethlehem, Pennsylvania, 12 November 1991.

WHITE, Gregory J., Associate Professor, "Naval Ship Design: U.S. Navy Structural Design Criteria," Center for Advanced Technology for Large Structural Systems Seminar, Lehigh University, Bethlehem, Pennsylvania, 10 December 1991.

WHITE, Gregory J., Associate Professor, "Naval Ship Design: Reliability-Based Ship Structural Design", Center for Advanced Technology for Large Structural Systems Seminar, Lehigh University, Bethlehem, Pennsylvania, 14 January 1992.

WHITE, Gregory J., Associate Professor, "Determining the Effects of Corrosion on Steel Structures: A Probabilistic Approach," Offshore Mechanics and Arctic Engineering Conference, Calgary, Alberta, Canada, 7-11 June 1992.



# Hydromechanics Laboratory

Professor Roger H. Compton  
Director

The primary functions of the Naval Academy Hydromechanics Laboratory (NAHL) are to support education and research in ship hydromechanics and ocean engineering. The facilities which constitute the NAHL are:

(1) 380' Towing Tank (380'x26'x16') - This premier facility features two towing carriages and a servo-controlled, electrohydraulically activated, dual flap wavemaker. Both towed and self-powered ship models can be tested in calm water, regular waves, and irregular waves. All waves generated are long-crested. Open water propeller characteristics can be determined by means of a propeller boat. Maneuvering characteristics can be evaluated by means of a large amplitude, horizontal planar motions mechanism. Most testing is done at model speeds up to 25 fps, but special tests have been run at speeds as high as 48 fps. Surface ship and submarine models can be tested. A drydock and finger pier located at the North End of the basin can be isolated from the main tank by means of closeable drydock doors.

(2) 120' Towing Tank (120'x8'x5.5') - Ship models up to about 6 feet in length can be towed in calm water, regular waves, and irregular waves. Long-crested waves can be generated by a wavemaker which is effectively a 1/3 scale model of the wavemaker in the 380-foot towing tank. Both deep and shallow water experiments are run in this facility. The tank can be configured with a false bottom to simulate various shoaling water conditions. The powered carriage can attain speeds as high as 13 fps. The tank is also equipped to perform gravity tow (constant force) model testing.

(3) Coastal Engineering Tank (52'x48'x2') - This L-shaped tank is equipped with a piston-type wavemaker and a moveable bridge for positioning wave probes. Small scale breakwaters, groins, jetties, and harbor arrangements can be studied with respect to wave reflection, refraction, transmission, and absorption properties. Wave guides allow the basin to be subdivided for multiple experimental setups.

(4) Circulating Water Channel (Test Section 5'x1.3'x1.3') - This small, free-surface water channel with a top speed of 12 fps is used primarily for flow visualization around control surface models and cavitating propeller models. Quantitative measurements of hydrodynamic forces on rudders and hydrofoils have also been made. The channel

can be pressurized from +6 psig to -12 psig to adjust model cavitation numbers.

(5) Computer Workstations - A number of Hewlett-Packard workstations are available for midshipmen, staff, and faculty use to acquire and analyze measured data and to define hull shapes using the FASTSHIP program. The capability exists to use the FASTSHIP offset files to cut hull models on a numerically-controlled milling machine located adjacent to the NAHL. Additionally, several Zenith PC's are available for data analysis as testing progresses.

(6) Stability/Ballast Tank (24'x12'x3.5') - This tank is used to investigate the hydrostatic stability characteristics of ship models--inclining experiments and righting arm experiments--as well as being used to ballast models in preparation for testing in the 380-foot or the 120-foot towing tanks.

All of the operating facilities are electronically linked via remote terminals to a host computer located in the control room for the 380-foot tank. The host computer not only permits speed and consistency in data acquisition and analysis from all facilities, but is integral to the control and sequencing of experimental hardware used in testing.

The NAHL Staff is a small, multi-talented group which plans, sets-up, performs, and interprets the measured data from experimental programs undertaken for midshipmen, faculty, and certain outside governmental agencies. The staff of 10 consists of 6 graduate engineers/naval architects, 3 engineering technicians, and an office manager/secretary. Liaison with the Naval Academy faculty is maintained by an appointed Laboratory Director who is also a member of the teaching faculty.

Notable facilities improvements begun or completed during the current reporting period include: (1) proposals for the laboratory's host computer have been received, reviewed, and returned to Naval Regional Contracting Center, and contract award is imminent; (2) design, fabrication, and testing of a wind generating system for the 380-foot tank have been accomplished by the laboratory staff; and (3) design, fabrication, and installation of a computer workstation/observation module for the low speed carriage in the 380-foot towing tank were accomplished by the laboratory staff.

Academic programs continue to reflect the

## HYDROMECHANICS LABORATORY

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benefits of the Laboratory's participation in significant research efforts for the Navy, the Coast Guard, and the National Science Foundation. Programs have included: (1) submerged vehicle model testing (Naval Coastal Systems Center); (2) physical modelling of combatant in beam winds and waves in both intact and damaged conditions (Naval Sea Systems Command); (3) vertical slotted breakwater studies (National Science Foundation); (4) side-by-side semiplaning boat model testing in irregular and regular head sea conditions (U.S. Coast Guard); (5) submarine series testing of tail cone/control surface configuration variations (Naval Coastal Systems Center); (6) support of SUPERTANK project (Army Corps of Engineers); (7) nonlinear seakeeping research (David Taylor

Research Center); (8) nonlinear wave phenomena (Office of Naval Research); (9) ocean wave group characteristics studies; (10) SWATH TAGOS-19 control surface loads study (Naval Sea Systems Command); (11) planing hull pressure measurements (U.S. Coast Guard); and (12) mooring studies (Naval Facilities Engineering Command).

Experimental research studies with intense midshipmen involvement have included: (1) racing oar blade propulsion studies; (2) Naval Sea Systems Command planing boat series testing in calm water; (3) open water propeller testing in non-axial flow conditions; (4) slotted breakwater testing; (5) development of a circular wave basin; and (6) acoustic mapping of turbulent jet flow.



# Publications

ANDERSON, Nancy L., Naval Architect, "An Experimental Validation of Roll Gyradius Assumptions and Roll Decay Model Test Procedures," Division of Engineering and Weapons Report EW-20-91, December 1991.

The *USS Philippine Sea* (CG58) was inclined and sallied in August 1988, at Portland, Maine. The availability of the resulting full scale test data and a large test model made it possible to investigate the validity of using scale models to estimate roll damping and virtual roll inertia properties of a hull form. In response to the Naval Sea Systems Command work statement dated 9 May 1989, sallying and inclining tests were performed in the U.S. Naval Academy's Hydromechanics Laboratory (NAHL). Objectives of the study included the experimental validation of the assumed standard value of roll gyradius (40% of the beam); the evaluation of added inertia characteristics of this hull form; and any effect of near wall, shallow water, or initial heel angle on roll behavior and roll decay. Given the inclining and sallying data from the May 1988 inclining of CG-58, a 1/22.67 scale model was ballasted to simulate the scaled displacement of CG-58 at distinct roll gyradius conditions. Estimates of added roll inertia were obtained by comparing the dynamic model in two conditions. First, the ship model was rigged as a pendulum and swung in air at various gyradius settings. Second, the ship model was floated, and roll decay data were collected for each of the gyradius settings. Roll decay traces were also obtained in near wall and shallow conditions.

ANDERSON, Nancy L., Naval Architect, co-author, "The International Marine Software Associates' 'IMSA Definition File': A Neutral Hull Description Standard," *Proceedings of the Marine Computers '91 Symposium*, New England Section of the Society of Naval Architects and Marine Engineers, Burlington, Massachusetts, September 1991, pp. 1-34.

The need for a standardized mechanism for passing hull-related data within the marine community has become more and more obvious with the rising number of marine software products available and the decreasing cost of high-powered personal computers. Individual members of the software development community have joined forces in order to propose a solution to this need; they have formed the International Marine Software Associates (IMSA). IMSA is a closely-knit organization of marine software development companies with complementary products. As well as being a vehicle

for improving promotional efficiency of its members, the principal purpose for the existence of IMSA is to offer leadership in the development and promotion of an open and unified hull file standard-the "IMSA Definition File" (IDF). This file currently encompasses hull and appendage geometry in various formats, such as sectional data, surface mesh data, and Non-Uniform Rational B-Splines (NURBS) surface data, as well as hull parameters. The underlying theme of the file is to incorporate as much pertinent information as possible while keeping the simplicity of the file intact.

This paper gives an overall view of the file specification, including the rationalizations behind the creation and the design of the file format. A complete example is presented.

COMPTON, Roger H., Professor, "Resistance and Seakeeping Database for U.S. Coast Guard 157-Foot WLM," U.S. Coast Guard Report No. CG-D-07-91, July 1991.

Effective horsepower, sinkage, and trim in calm water as functions of speed for the U.S. Coast Guard 157-Foot WLM buoy tender are derived from the results of 1/32 scale model tests in deep and shallow water. Long-crested, head seas testing of the same model at three discrete speeds resulted in normalized response curves for pitch, heave, relative motion at Station 1 (of 10), and added resistance due to encountered waves.

COMPTON, Roger H., Professor, and James J. SHAUGHNESSY, Naval Architect, "SWATH (TAGOS-19) Ruddelizer Loading In Irregular Waves: An Experimental Study," Division of Engineering and Weapons Report EW-13-92, June 1992.

A unique aspect of a novel new ship type, the Small Waterplane Area Twin Hull (SWATH) ship, is the inclined after control surface used for both steering and vertical motion control called the "ruddelizer." Its novel configuration raises questions about the magnitudes of seaway-induced structural loadings which the ruddelizer is likely to experience. Conventional design practices for rudders and horizontal control surfaces (sail planes, bow planes, and stern planes) for submarines are related, but not similar enough to use with confidence for SWATH ruddelizer design. A large model of TAGOS-19 was prepared for testing in irregular waves. An extensive test series involving three sea states, eight ship-to-wave headings, and four ruddelizer deflection angles was undertaken. For all



tests, the model was at zero speed and free in all six degrees of freedom.

COMPTON, Roger H., Professor, John J. ZSELECZKY, Naval Architect, and William S. ABRAMS, Ensign, USN, "Underway Inclining Experiments Performed on a Planing Hull Model," *Proceedings of Intersociety High Performance Marine Vehicle Conference (HPMV'92)*, Arlington, Virginia., June 1992, pp. PC104-PC116.

The overall transverse stability of planing boats at post-hump speeds is investigated using a 1:8 model of a current U.S. Coast Guard hull. The results of a series of tests in which static heeling moments were applied to the moving model which was free to heel, trim, and rise (or sink) are presented and discussed. Experimental techniques are described and data are compared to available related results.

The results of this experiment show that the equilibrium conditions change as ship speed, heeling (righting) moment, and the center of gravity position change.

DAWSON, Thomas H., Professor, David L. KRIEBEL, Associate Professor, and Louise A. WALLENDORF, Ocean Engineer, "Experimental Study of Wave Groups in Deep-Water Random Waves," *Applied Ocean Research*, 13, 3 (June 1991), 116-131.

Results from a laboratory study of wave groups in random seas are presented for Bretschneider and JONSWAP sea states. A distinction is made between general crest-envelope crossings of a threshold level and those involving groups of two or more wave crests. Measurements show that the average duration of a run of high waves in groups and the average interval between such groups are significantly greater than the values found for general envelope crossings, since many large waves occur by themselves and not in groups. Experimental results for these average values, as well as for probability density functions of time durations and intervals, are found to be characterized broadly by linear similarity at high threshold levels. Average envelope durations and intervals are then shown to be consistent with standard envelope theory of random waves when used with parameters derived from truncated amplitude spectra and non-linear crest statistics. Probability density distributions for envelope durations and intervals are shown to be described approximately by Gamma functions rather than by the commonly assumed exponential function. Average durations and intervals for groups of two

or more wave crests, as well as their associated probability density functions, are also shown to be theoretically related to the corresponding envelope statistics.

WATERS, Thomas J., Naval Architect, "An Evaluation of Small Scale Model Tests in Assessing Submarine Stability Under Ice," Division of Engineering & Weapons Report EW-19-91, December 1991.

This project explores the feasibility of using a small scale model to assess the effects of net buoyancy, submerged metacentric height (BG), and initial heel angle on the behavior, at impact, of a submarine attempting to surface through ice. An existing submarine model was modified to represent a current attack submarine in terms of length-to-diameter ratio and appendage geometry (sail, stern planes, and rudders). The 1:31 scale model was ballasted to a neutral displacement, zero trim (submerged), and a prescribed mass distribution about the center of gravity. Tests using the submerged model were conducted in the USNA Hydromechanics Laboratory facilities to determine: the location of the vertical center of gravity (inclining), submerged roll period at varying BG conditions (sallying), and ascent rates for different conditions of positive buoyancy. The model response upon impact with a simulated ice surface was then videotaped in varying conditions of positive buoyancy, BG, and static heel.

ZSELECZKY, John J., Naval Architect, co-author, "Experimental Determination of Nonlinearities in Vertical Plane Ship Motions," *Proceedings of the Nineteenth Symposium on Naval Hydrodynamics*, Seoul, Korea, August 1992, 53-70.

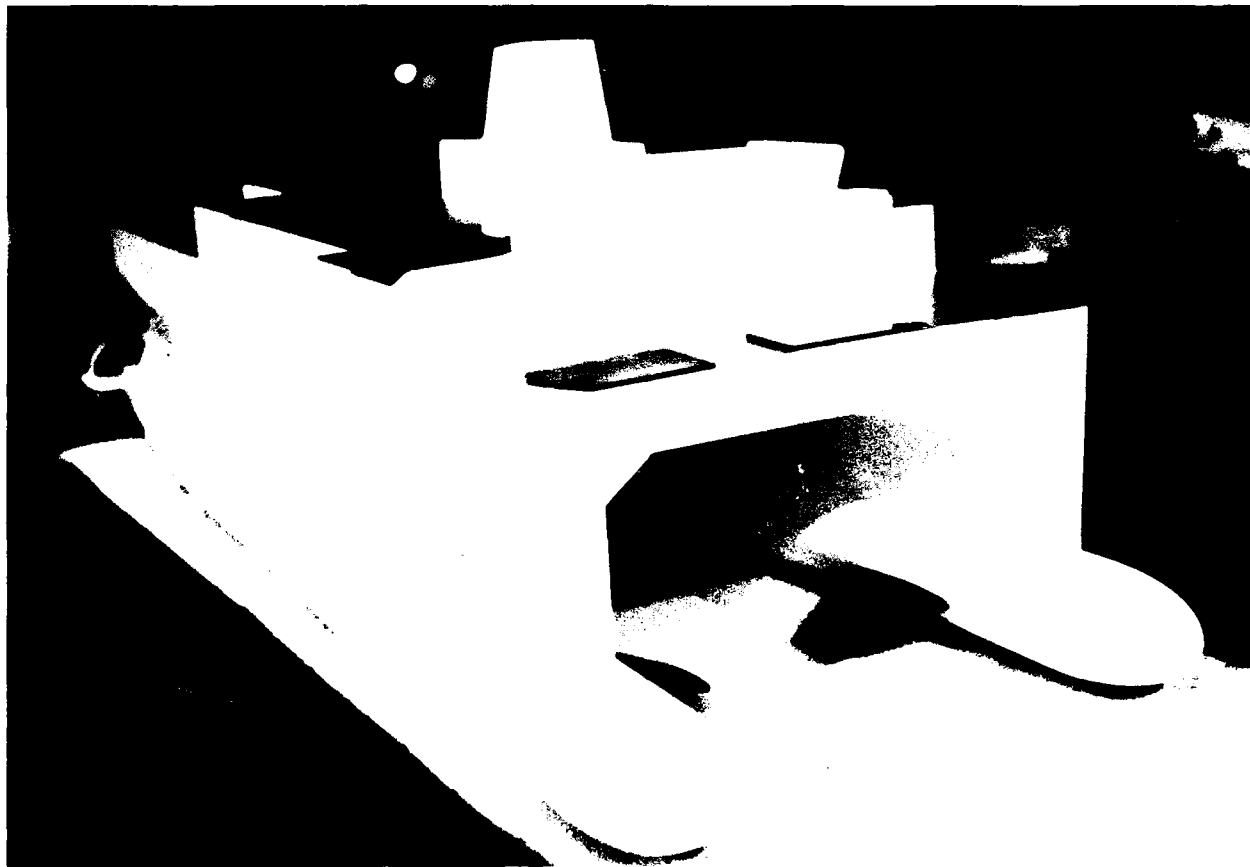
Experiments have been conducted in regular and random waves of varying severity (steepness) on a model of a standard hull form. Variation of the heave and pitch transfer functions, as wave steepness was varied, indicate a nonlinear motion behavior for this hull. The response has been modelled as a Volterra functional expansion carried out to include quadratic and cubic terms. The higher order kernels of the expansion have been determined from the regular wave data and have been confirmed by polyspectral analysis of random wave data. The results show how the usual assumption of linearity of response can lead to incorrect predictions, and also show the effect of non-Gaussian random behavior in both the input (waves) and the responses.

## HYDROMECHANICS LABORATORY

ZSELECZKY, John J., Naval Architect, Bruce C. NEHRLING, Professor, and Roger H. COMPTON, Professor, "Side-by-Side Testing of Hard Chine and Round Bilge Semi-planing Models in Waves," *Proceedings of Intersociety High Performance Marine Vehicle Conference (HPMV'92)*, Arlington, Virginia, June 1992, pp. PC60-PC71.

Two patrol craft models, with similar length-to-beam ratios, displacement-to-length ratios, and pitch gyrodii, were instrumented to measure pitch motion,

heave motion, and vertical accelerations at three longitudinal locations. One model had hard chines, while the other one had round bilges. Tests were run at three speeds in both regular and irregular long-crested head seas, with the models arranged side-by-side, so that they encountered the waves simultaneously. The seakeeping motions and accelerations of the two models are compared and the merits of side-by-side model testing are discussed.



## Presentations

ANDERSON, Nancy L., Naval Architect, "The International Marine Software Associates' 'IMSA Definition File': A Neutral Hull Description Standard," Marine Computers '91 Symposium, New England Section of the Society of Naval Architects and Marine Engineers, Burlington, Massachusetts, September 1991.

COMPTON, Roger H., Professor, John J. ZSELECZKY, Naval Architect, and William S. ABRAMS, Ensign, USN, "Underway Inclining Experiments Performed on a Planing Hull Model," Intersociety High Performance Marine Vehicle Conference (HPMV'92), Arlington, Virginia, 24-27 June 1992.

ZSELECZKY, John J., Naval Architect, "Experimental Determination of Nonlinearities in Vertical Plane Ship Motions," Nineteenth Symposium on Naval Hydrodynamics, Seoul, Korea, August 1992.

ZSELECZKY, John J., Naval Architect, Bruce C. NEHRLING, and Roger H. COMPTON, Professors, "Side-by-Side Testing of Hard Chine and Round Bilge Semiplaning Models in Waves," Intersociety High Performance Marine Vehicle Conference (HPMV'92), Arlington, Virginia, 24-27 June 1992.



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# Weapons and Systems Engineering

Professor E. Eugene Mitchell  
Chair

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**R**esearch within the Weapons and Systems Engineering Department continued to provide the faculty with an environment for professional growth and the opportunity to remain abreast of today's rapidly advancing systems technology. Additionally, every graduating Systems Engineering major participated in independent research, design, and development projects which reinforced the essential interface between academics and practical application.

Every faculty member, both civilian and military, participated in independent research directed toward areas of interest to the U.S. Navy, or supported midshipmen research programs in an advisory capacity. Faculty research areas included robotics and machine vision for robots, compensator design, chaos in simulations, machinery health monitoring-fault diagnosis, and several investigations involving computer control, as well as software and hardware application to specific systems problems.

Strong emphasis continues on the faculty-midshipman relationship during the student independent research course. Each midshipman was assigned both an administrative and a technical adviser. These advisers not only provide support of a technical nature, but also emphasize planning, schedule development, and effective oral and written presentations. Thus, the student is introduced to all aspects of the research process. Typical examples of midshipmen research topics include a three-dimensional vision system for remote vehicle guidance, voice control of a CD player, light-guided carts, machine vision targeting for the pistol range and a three-dimensional "virtual reality" system, in which the observer's head motion controlled computer images and sound.



Funding for research activities has been available from multiple sources, including grants and contracts from various federal agencies and Navy laboratories, as well as funding from within the Naval Academy. This year's sponsors include the Naval Academy Research Council, the David Taylor Research Center, and the Naval Surface Warfare Center.

## Sponsored Research

### Dynamic Model of Phalanx Gun Mount

Researcher: Associate Professor Thomas E. Bechert

Sponsor: Naval Surface Weapons Center

This ongoing research project is developing the dynamic equations of motion for the Phalanx Close-In Weapon System (CIWS). For purposes of this project, the CIWS comprises three coupled rigid bodies: the spin unit includes the gun barrel assembly of the Gatling gun, rotating at high speed about the spin axis, which is parallel to the cluster of gun barrels and is fixed relative to the elevation unit. The elevation unit includes all equipment which rotates about the elevation axis. This includes the tracking radar equipment and the gun mount assembly, but excludes the spin unit itself. The train unit supports the elevation unit on its bearings. The train unit includes all equipment which rotates about the train axis (the azimuth axis), but excludes the elevation unit and the spin unit. The spin unit is rotated about its axis by the gun drive system torque. The elevation unit and the

train unit are rotated about their axes by the elevation and train servo motor torques.

Lagrangian methods were used to derive the second order differential equation of motion for each of the three rotating units. The gyroscopic coupling between units shows up in the cross coupling terms in the equations. The high speed spin unit is assumed to be balanced and symmetric with respect to the spin axis, with its center of mass located on that axis. No such restrictive assumptions are placed on the elevation and train units. Their models accommodate off-axis centers of mass. Furthermore, product of inertia terms appear in the equations, because of the assumed asymmetry of the elevation and train units. The mathematical model will be used in computer simulations to evaluate control algorithms and to support servo motor selection.

### Investigation into the Generalization Capabilities of Back-Propagation Neural Networks

Researcher: Assistant Professor William I. Clement

Sponsor: Naval Academy Research Council (ONR)

The generalization capabilities of back-propagation neural networks were explored. One of the stated attributes of neural networks, as applies to pattern recognition, is their ability to generalize the data on which they have been trained and thus correctly categorize patterns that vary to some degree from the training data. The generalization of the data applies to patterns that belong to one of the classes on which the network has already been trained. This research explored the ability of a back-propagation neural network to extract generalizations which are independent of object class. Specifically, rotational invariance was studied. The approach taken was to train a neural network

on a set of pattern classes which undergoes rotation and then analyze its response to other pattern classes to see if the generalization extended to these. Both the output and hidden-layer neurons were studied in the effort. The results show that the generalizations formed by a back-propagation neural network are restricted to those pattern classes on which it was trained.

Results of this study were published and presented at the Twenty-third Annual Pittsburgh Conference on Modeling and Simulation, 30 April-1 May 1992. Another paper on this topic was submitted to the IEEE Transactions on Neural Networks for publication.

### Applications of Neural Networks to Structureborne Noise Reduction

Researcher: Assistant Professor William I. Clement  
Sponsor: Naval Academy Research Council (ONR)

During a Naval Sea Systems Command acoustic trial a Structureborne Noise Engineer was available for review between 10,000 and 15,000 400-point acceleration spectra from which to obtain an accurate assessment of contributing sources to radiated noise problems. This analysis is a tedious and time-consuming task, and the time allotted for investigation during the trial is fairly limited. Though extensive analysis is performed after the trial (i.e., off-line), a significant cost savings could be realized if more of the analysis were performed during the acoustic trial--i.e., real-time analysis. This would allow subsequent runs (during the same acoustic trial) to be focused on further isolating and identifying the specific noise source. Neural networks offer the possibility of automated, real-time data analysis which could lead to more thor-

ough and reliable results. Thus far in the investigation, a back-propagation neural network has been trained to filter out blank or empty data channels with 100% accuracy. This is the data validity problem. This study needs to be extended to the detection of data channels which, though not blank, are nonetheless suspect and therefore not useful for analysis. A second problem is the localization of the specific source of radiated noise--the vibration analysis problem. (Given a report of radiated noise, identification of the hull frame from which it emanates will be sought by examination of the recorded spectra.) Further research was conducted during the intersessional period (June-August 1992) and concentrated on finding neural network solutions to these two problems--data validity and vibration analysis.

### Phalanx Gun Fire Control Algorithm

Researchers: Professor Robert DeMoyer and  
Associate Professor Terrence E. Dwan  
Sponsor: Naval Surface Weapons Center, Dahlgren

The Navy is engaged in a re-design of the Phalanx Gun. An important part of the re-design is an update of the fire control algorithm. Working with the prime contractor, General Dynamics, the re-

searchers have reviewed the progress in target state estimation over the past fifteen years, and are in the process of evaluating new approaches. The work will continue with creative new developments.

### Development of Advanced Instructional Robotic Systems Laboratory Hardware and Software

Researcher: Professor Kenneth A. Knowles  
Sponsor: Naval Academy Instructional Development Advisory Committee

During the 1991 summer intersessional period a PC-based control of the two high performance PUMA industrial robots, located in the Weapons and Systems Engineering Advanced Robotics Laboratory, was developed. This permitted the

integration of vision and complex multi-robot task controls for robotics course exercises, advanced student projects, and demonstrations. The two PUMA arms were connected, via a PC link, to two kinematically similar teleroptic master controllers.

### **Statespace Control of an ICR Gas Turbine Engine**

Researcher: Associate Professor Jerry W. Watts

Sponsor: David Taylor Research Center, Annapolis Laboratory

The power plant for the electric drive naval ships of the future will be a recuperated, intercooled, variable-area-turbine-nozzle gas turbine engine. The controller for this engine will be a computer using statespace methods of control which include

the possibility of several modes. A modular simulation model of the Intercooled Regenerated engine is being developed in Advanced Continuous Simulation Language, and a statespace controller is being developed using the software MATLAB.

### **Use of an Illumination Model in the Recovery of Blood Vessel Topography from Human Conjunctiva Images**

Researcher: Assistant Professor Carl E. Wick

Sponsor: Naval Academy Research Council (ONR)

The human bulbar conjunctiva, commonly known as the "white of the eye", is a unique site where the body's smallest blood vessels may be studied in a relatively non-invasive manner. Currently there is no automated system which can extract blood vessel information from photographs of the conjunctiva. Instead, researchers must gather data manually. The objective of this research is the development of a comprehensive model of the illumination and reflection processes contributing to a photographic image of the conjunctiva. This model will provide information which will guide the development of reliable automated blood vessel data extraction programs. A simplified physical model of the conjunctiva scene was developed. Geometric relations were found which describe all known fun-

damental illumination and reflection effects on the physical model. The relations were experimentally verified, and mathematical expressions were developed for each effect. The influence of a translucent medium representing the conjunctival membrane was added to the model, and expressions were found which satisfactorily describe its presence. A computer simulation was developed from the mathematical model and was experimentally verified against a phantom, achieving the objective of this research. Follow-on work will explore image information indicating the relative depth of a blood vessel in the conjunctival membrane and blood vessel parameter extraction from these images.

### **Stereo Vision-Controlled Bilateral Telerobotic Remote Assembly Station**

Researcher: Midshipman 1/C Robert L. Dewitt, USN

Adviser: Professor Kenneth A. Knowles

Sponsor: Trident Scholar Program

This Trident research project developed a bilateral six-degree-of-freedom telerobotic component assembly station utilizing remote stereo vision assisted control. The component assembly station consisted of two (i.e., bilateral) Unimation PUMA 260 robot arms and their associated controls (slave robots), two Panasonic miniature closed-circuit television camera (CCTV) systems, and an air compressor. Each PUMA arm had six degrees-of-freedom and was independently controlled by a VAL II computer system. Each arm had a pneumatic end effector (gripper) attached via a

compliant wrist coupling. The two cameras were positioned to provide the operator with working stereo view of the assembly area. The assembly station arms were controlled remotely via kinematically similar master controllers, which were designed to provide comfortable operator control while in use. The master controllers provided joint angles and gripper status information necessary to control the slave robot arms. An 80386-based personal computer provided the interface between the master controllers and the VAL II computers of the slave arms. The operator was provided real-

time stereo imaging via the two CCTV systems. The images of these two systems were combined optically via a lightweight cap-mounted periscope mirror assembly to permit human depth perception. A series of assembly station tasks, ranging in difficulty and complexity, was used to assess and

demonstrate the capabilities of the entire system. The completed station was capable of disassembling a ball point pen into four parts, and then reassembling it in an average time of approximately five minutes. The telepresence provided by the stereo vision was judged to be excellent.

### **Active Control of Foundation Transmissibility Using Magnetostrictive Actuators**

Researcher: Midshipman 1/C Kenneth E. Poorman, USN

Adviser: Associate Professor Robert S. Reed

Sponsor: Trident Scholar Program

The recent development of Terfenol, a magnetostrictive rare-earth alloy, which undergoes large geometric changes when placed in a magnetic field, has significant applications in the area of active vibration control. By controlling an electromagnetic field, these alloys can be made to exert significant forces, creating subsequent motion or vibrations. If these vibrations are controlled correctly, usually with the help of a computer, they can significantly reduce or cancel unwanted vibrations which may be present in the system.

In this project, a typical vibration problem encountered with rotary equipment (such as motors), is simulated. In this case, a small aluminum table was constructed and a variable speed, DC-motor was mounted on top. The table might simulate an automobile's chassis or ship's hull, for example, which needs to be free of vibrations. As the motor turns, it creates vibrations which are transmitted through the table to its "mounting platform." Because the motor can rotate at different speeds, it vibrates the table at different frequencies and is capable of exciting different "harmonic" modes in the table.

To control (i.e., eliminate) the undesirable vibrations, magnetostrictive actuators are mounted to the table--one to each of its two supports. In order to control accurately the actuators, feedback from the system is obtained through various sensors to the system. These sensors, an array of accelerometers, force rings, and strain gauges, are linked directly to a controller which processes the information and sends the appropriate control signals to the actuators.

It has been shown by other researchers, among them Associate Professor Reed of the Weapons and Systems Engineering Department, that active control of simple systems is possible, if the actuator is an integral part of the original system. This research project, however, is more concerned with modifying existing systems, thereby testing the feasibility of adding active vibration control to them.

The project demonstrated that magnetostrictive actuators could successfully reduce the vibrations of a foundation which was being excited by a variable speed DC motor with an eccentricity.



## Independent Research

### Symbolic Inverse of Polynomial Matrices

Researcher: Professor E. Eugene Mitchell

When writing dynamic equations of motion from physical systems, many times the result is a set of simultaneous integral-differential equations. Common examples are the equations resulting from applications of Kirchoff's loop and node laws to electrical circuits.

These equations are easy to write, but are difficult to solve in the time domain. However, Laplace Transforms make a simple conversion to a set of simultaneous algebraic equations. The algebra is straightforward, but is messy, because the coefficients of the unknowns are polynomials in the Laplace variable  $s$ .

For small sets, two and sometimes three equations, with nice numbers, solutions via Cramer's Rule or matrix inverse may be used. Larger sets

and those with realistic numbers are too difficult to work in a classroom or homework environment. Although it would be a valuable tool, there was no known algorithm being used in academic circles.

The purpose of this research was to develop an algorithm that would allow one to symbolically invert a matrix of polynomials. As it turns out, the inversion algorithm was published several years ago in a relatively unknown British journal.

A True Basic program was written that allows one to find the symbolic inverse of a matrix of polynomials in  $s$ . The program output may be the inverse of the matrix, the solution of all unknowns, or a single input-output transfer function. The program is expected to find application in ES201, ES303, and ES309.



## Research Course Projects

### Application of Direct Recovery of Three-Dimensional Scene Geometry from Binocular Stereo Disparity

Researcher: Midshipman 1/C Matthew P. Jensen, USN  
Adviser: Assistant Professor William I. Clement

The title of this research project is taken from an article of the same name authored by Richard P. Wildes and published in the IEEE *Transactions on Pattern Analysis and Machine Intelligence*, Vol. 13, No. 8, August 1991, pp. 761-774. This research focused on the application of the theory presented in that paper. An 80386-based computer with advanced vision processing equipment (DT2867 and DT2878 image processing boards) was used to

implement the algorithms described. The difference in the scene geometry as seen by two cameras positioned in stereoscopic arrangement is used to calculate the orientation of surfaces in the scene. The equations for these surfaces can then be used to reconstruct the scene. Because of the late arrival of the vision processing equipment, this research, which began as an ES496 project, was continued into the summer session.



## Design Course Projects

Each Systems Engineering major enrolls in ES402, Systems Engineering Design, during senior year. This course is the capstone of the Systems Engineering curriculum. The student is required to propose, design, construct, test, demonstrate, and evaluate a system of particular personal or general professional interest.

The ES402 design course requires the combined effort of the total Systems Engineering Department faculty. Military instructors normally function as project monitors and help with organization, administration, and scheduling of individual projects. Civilian faculty function as technical advisors, and

military and civilian technicians supply the hands-on technical help.

Associate Professors Robert S. Reed, Olaf N. Rask, and Professor Kenneth A. Knowles provided the course coordination and administrative effort, and were assisted by Associate Professors Thomas E. Bechert, C. George Brockus, Terrence E. Dwan, and Jerry W. Watts, and by Professors Robert DeMoyer, and E. Eugene Mitchell, who provided technical and systems design assistance and expertise for the listed design course projects.

The results of academic year 1991-1992:

### **SAE Walking Machine Project**

Midshipmen 1/C Benjamin A. Atkins, George D. Doney,  
Brian C. Dozier, Christopher A. Eckerle, Frank J. Kochenash,  
Paula K. Lair, Joseph J. Lienert, Randy J. Roberge,  
Douglas R. Rogers, Michael J. Sipe, and  
Daniel R. Truckenbrod, USN  
Adviser: Captain Scott J. Fuller, USMC

### **Systems Ball Cart Competition**

Midshipmen 1/C Stephen C. Augustin and  
Mark W. Davison, USN  
Adviser: Captain Thomas H. Rich, USMC

### **Systems Ball Cart Competition**

Midshipmen 1/C Terry L. Baggett and  
Thomas R. Buchanan, USN  
Adviser: Lieutenant Duane E. Nestor, USN

### **Systems Ball Cart Competition**

Midshipmen 1/C Neal D. Borkert and  
Scott R. Coughlin, USN  
Adviser: Lieutenant Commander William R. Cox, USN

### **Systems Ball Cart Competition**

Midshipman 1/C Christopher J. Boyle, USN  
Adviser: Lieutenant Commander Robert A. Shafer, USN

### **Systems Ball Cart Competition**

Midshipmen 1/C Jeffrey G. Conway  
and Todd W. Ferry, USN  
Adviser: Thomas H. Rich, USMC

**Systems Ball Cart Competition**

Midshipmen 1/C Paul G. Creighton and  
William R. Stevens, USN  
Adviser: Captain Brent A. Douglas, USMC

**Systems Ball Cart Competition**

Midshipmen 1/C Jeffrey J. Dolven and  
Brian L. Luke, USN  
Adviser: Captain Scott J. Fuller, USMC

**Systems Ball Cart Competition**

Midshipmen 1/C Un Kyong Hand, Bruce A. Naley,  
and Cory R. Ondrejka, USN  
Adviser: Lieutenant William B. Taylor, USN

**Systems Ball Cart Competition**

Midshipmen 1/C Christopher J. Linnane and  
Hal T. Perdew, USN  
Adviser: Lieutenant Commander Joseph T. Cronauer, USN

**Ultrasonic Flashlight**

Midshipman 1/C Douglas P. Barber, USN  
Adviser: Lieutenant Commander Robert A. Shafer, USN

**Automatic Volume Control for Convertible Automobile**

Midshipman 1/C John F. Baron, USN  
Adviser: Lieutenant David S. Gilmore, USN

**Laser Communication: Receiver/Transmitter**

Midshipman 1/C Roland A. Bolado, USN  
Adviser: Lieutenant Commander William R. Cox, USN

**MIDI Drummer Performance Integrator and Mapper**

Midshipman 1/C Brian D. Brock, USN  
Adviser: Colonel James F. Kendrick, USAF

**Land Torpedo - Frequency Homing Cart**

Midshipman 1/C Matthew B. Cervarich, USN  
Adviser: Captain Brent A. Douglas, USMC

**Active Acoustic Jamming**

Midshipman 1/C Roderick L. Coward, USN  
Adviser: Lieutenant Commander William R. Cox, USN

**Golf Swing Replicator and Analyzer**

Midshipman 1/C Jeffrey D. Debrine, USN  
Adviser: Lieutenant William B. Taylor, USN

**Ultrasonic Flashlight**

Midshipman 1/C Jared V. East, USN

Adviser: Lieutenant Commander Joseph T. Cronauer, USN

**Computer Controlled Drawing on X-Y Table**

Midshipman 1/C Brian J. Finman, USN

Adviser: Lieutenant David S. Gilmore, USN

**Forward-Looking RPV**

Midshipman 1/C Patrick V. Foege, USN

Adviser: Colonel James F. Kendrick, USAF

**Remote Control Cart with 3-D Vision**

Midshipman 1/C Gregory K. Gaskey, USN

Adviser: Lieutenant Commander Joseph T. Cronauer, USN

**Stolen Vehicle Recovery System**

Midshipman 1/C Demetrios M. Geokezas, USN

Adviser: Lieutenant Stephen C. Lanier, USN

**Tape Following Security Robot**

Midshipman 1/C Ted D. Girdner, USN

Adviser: Colonel James F. Kendrick, USAF

**Industrial Security Robot**

Midshipman 1/C Daniel F. Goodwin, USN

Adviser: Colonel James F. Kendrick, USAF

**"MACE": Manually Activated Centurion - Roving Vision System**

Midshipman 1/C Timothy M. Hill, USN

Adviser: Captain Scott J. Fuller, USMC

**Remotely-Piloted Airborne Reconnaissance Vehicle**

Midshipman 1/C Michael L. Hudson, USN

Adviser: Lieutenant Commander Michael F. Dulke, USN

**Two-Dimensional Sonic Tracker**

Midshipman 1/C Thomas R. Huerter, USN

Adviser: Lieutenant Commander William R. Cox, USN

**Underwater Acoustic Signature/Identification**

Midshipman 1/C Ronald G. Jacobson, USN

Adviser: Captain Thomas H. Rich, USMC

**Automated Billiards Master**

Midshipman 1/C Joel R. Johnson, USN

Adviser: Lieutenant William B. Taylor, USN

**Remotely-Piloted Ship**

Midshipman 1/C Louie W. Johnson, USN

Adviser: Lieutenant Commander Richard L. Weston, USN

**Robotic Hand**

Midshipman 1/C Karl A. Kazarian, USN

Adviser: Lieutenant Commander Robert A. Shafer, USN

**Tracking Antenna for Tactical Satellite**

Midshipman 1/C Waqar A. Khan

Adviser: Lieutenant Duane E. Nestor, USN

**Remotely-Operated Camera Robot**

Midshipman 1/C Mark K. Kochalka, USN

Adviser: Lieutenant David S. Gilmore, USN

**Frequency Hopping Communication System**

Midshipman 1/C Fernando A. Ledantec, USN

Adviser: Lieutenant Commander Robert A. Shafer, USN

**Vision Tracking Device for the Control System**

Midshipman 1/C Ganghyeok Lee, USN

Adviser: Lieutenant Duane E. Nestor, USN

**Digital Locking Mechanism**

Midshipman 1/C Everett S. Marshall III, USN

Adviser: Lieutenant Commander Joseph T. Cronauer, USN

**Magnetohydrodynamic Propulsor**

Midshipman 1/C Mark M. Matthews, USN

Adviser: Lieutenant Stephen C. Lanier, USN

**Automobile Collision Avoidance Radar System**

Midshipman 1/C Kenton D. McHenry III, USN

Adviser: Lieutenant Commander Robert A. Shafer, USN

**Control of the Inverted Pendulum**

Midshipman 1/C Long K. Nguyen, USN

Adviser: Lieutenant Commander Michael F. Dulke, USN

**A Reduced Order State Space Controller for an Inter-cooled,  
Regenerated Gas Turbine Engine**

Midshipman 1/C Mark A. Olson, USN

Adviser: Lieutenant Commander Michael F. Dulke, USN

**Measurement of the Flow of Red Blood Cells in  
Capillaries by Image Processing**

Midshipman 1/C David C. Robinson, USN

Adviser: Lieutenant Stephen C. Lanier, USN

**Eye Position Recognition and Tracking**

Midshipman 1/C Abraham Sachs, USN  
Adviser: Lieutenant Duane E. Nestor, USN

**Satellite Communications and Radar/Radio Wave Propagation**

Midshipman 1/C Daniel J. Sander, USN  
Adviser: Lieutenant Commander Joseph T. Cronauer, USN

**Light/Reflection Tracking Cart**

Midshipman 1/C Aaron J. Smith, USN  
Adviser: Lieutenant Duane E. Nestor, USN

**Object Recognition and Orientation**

Midshipman 1/C Derrick J. Smith, USN  
Adviser: Lieutenant David S. Gilmore, USN

**Optical Tracking Software Application to the USNA**

**12 Meter Parabolic Antenna**

Midshipman 1/C Todd D. St. Laurent, USN  
Adviser: Lieutenant Stephen C. Lanier, USN

**Electronic Caddy**

Midshipman 1/C Joseph M. Taliaferro, USN  
Adviser: Lieutenant William B. Taylor, USN

**Remote-Control Vision Platform**

Midshipman 1/C Michael B. Tatsch, USN  
Adviser: Lieutenant Commander Joseph T. Cronauer, USN

**Computer/Robot Aide for the Handicapped**

Midshipman 1/C Lori L. Vanscoy  
Adviser: Lieutenant Commander Richard L. Weston, USN

**Infrared Data Transmission using Voice Recognition**

Midshipman 1/C James H. Ware III, USN  
Adviser: Lieutenant Commander Richard L. Weston, USN

**Land-Roving Reconnaissance Vehicle with Video Telemetry**

Midshipman 1/C William J. Wiseman IV, USN  
Adviser: Captain Thomas H. Rich, USMC

**Acoustic Phased Array in Air (to be used) for Direction Finding**

Midshipman 1/C Thomas A. York, USN  
Adviser: Lieutenant Commander Robert A. Shafer, USN

## Publications

BECHERT, Thomas E., Associate Professor, "Control Constraints in Deadbeat Response," *Proceedings of the Twenty-second Annual Pittsburgh Conference on Modeling and Simulation*, 22, 4 (May 1991), pp. 1929-1937.

Discrete-time control systems have capabilities which are not available in the continuous-time domain. One such capability is deadbeat response. The system error signal is assumed to be sampled with a sampling period of  $T$  seconds, with each sample processed by a digital controller. The controller output signal passes through a zero order hold and is applied to the controlled plant as the control force. The control force is therefore at a constant level during each sample period. With deadbeat response the system reaches steady state, with zero error, while minimizing  $N$ , defined as the number of sample periods to reach steady state. With deadbeat response the steady state error between input and output remains at zero, even between sampling instants. This description of deadbeat response is equivalent to the behavior of a finite-impulse-response filter. Thus, the closed-loop pulse transfer function of the deadbeat system is simply  $F(z)$ , a finite polynomial in  $1/z$  of order  $N$ . With the input signal assumed to be a unit step, the minimum value of  $N$  is found to depend only on the dynamic characteristics (the pulse transfer function) of the controlled plant, provided no constraints are placed on the magnitude of the control force. If the control force is found to exceed a specified upper limit, then more time must be allowed to reach steady state; that is, the value of  $N$ , the number of sample periods, must increase. Computation of the control force during each of the  $N$  sample periods involves a tedious long division process. The principal contribution of this paper is to replace the long division by a sequence of matrix multiplications, where the matrix entries are simply the given coefficients in the pulse transfer function of the controlled plant, and the coefficients in  $F(z)$ . With this simplification the design equations for the digital controller are easily programmed, and the design engineer has a convenient tool for selecting a digital controller to provide deadbeat response without violating specified constraints on the control force magnitude. The paper includes a numerical design example, with several graphs which show how increasing the value of  $N$  permits deadbeat response to be achieved with smaller control forces.

CLEMENT, William I., Assistant Professor, "Exact Damping Ratio Specification on the Root Locus Plot," *Proceedings of the Twenty-Second Annual*

Pittsburgh Conference on Modeling and Simulation, 22, 4, (May 1991), pp. 1914-1920.

Construction rules for the Evans Root Locus are well established. Most of these rules provide only approximate sketching guidelines, but a few give exact locus location. Notably, the procedures for finding real-axis breakaway and break-in and  $j\omega$ -axis crossing are exact. This paper discusses a non-iterative method for finding the exact system parameter value necessary to place a pair of complex conjugate poles on a given  $\zeta$  (constant- $\zeta$ ) line. Such a requirement often arises when percent overshoot is specified. Additionally, inasmuch as real-axis breakaway/break-in and  $j\omega$ -axis crossing also correspond to particular values of  $\zeta$ , this technique applies equally well to those situations.

DEMOYER, Robert Jr., Professor, "Parameter Estimation Leading to Closed-Loop Response Prediction in an Undergraduate Servomechanism Course," *Proceedings of the International Federation of Automatic Control Conferences on Advances in Control Education*, 24-25 June 1991, pp. 186-190.

The primary objective of the course is to predict closed-loop response of a velocity compensated position control system based upon the measured behavior of each of the components. Students write their own least squares parameter estimation programs in MATLAB. This language is particularly well suited to the purpose due to its matrix orientation and excellent graphics. All measurements are carried out by a computer-controlled oscilloscope and imported into MATLAB over the IEEE-488 bus. Most scope control programs are written by the students in PASCAL. Parameter estimation varies from the simple proportionality constant of a potentiometer to parameters not linearly related to a measured quantity such as motor time constant. Ultimately, the students compare plots on the same axes of a closed-loop step response predicted by the estimated parameters to the actual step response measured by the scope.

DWAN, Terrence E., Associate Professor, and Colleen S. SMILEY, Assistant Professor, "System Identification - Human Tracking Response," *IEEE Transactions on Education*, February 1992, pp. 31-37.

Engineers often analyze and simulate mechanical, electrical, or combinational systems. They seldom, however, use the same techniques applied toward



human beings. The most accurate model of the newest high-tech aircraft would be incomplete without a model of the pilot. Humans exhibit many unique characteristics which must be taken into account in system design. This paper discusses an experiment performed at the U.S. Naval Academy to develop transfer functions for human tracking response. The experiment tested a subject's ability to track a one-dimensional, sine-wave tracking to determine time delay and the transfer function. Using system identification techniques, the best models were selected for each of five different frequencies of the test sine-wave input.

Bode plots, magnitude, and phase for the system that best models the way humans react are given. Step responses for these models are also given. This entire process provides an excellent tutorial in programming, system modeling, and simulation.

DWAN, Terrence E., and Jerry W. WATTS, Associate Professors, "A Model and Statespace Controllers for an Intercooled Regenerated (ICR) Gas Turbine Engine," *The American Society of Mechanical Engineers*, 92-GT-43, June 1992, pp. 1-12.

A two-and-one-half spool gas turbine engine was modeled using the Advanced Computer Simulation Language (ACSL), a high-level simulation environment based on FORTRAN. A possible future high efficiency engine for powering naval ships is an intercooled, regenerated (CR) gas turbine engine; these features were incorporated into the model. Utilizing sophisticated instructions available in ACSL, linear statespace models for this engine were obtained. A high-level engineering computational language, MATLAB, was employed to exercise these models to obtain optimal feedback controllers characterized by the following methods: (1) state feedback; (2) linear quadratic regulator (LQR) theory; and (3) polygonal search. The methods were compared by examining the transient curves for a fixed off-load, and on-load profile.

DWAN, Terrence E., Associate Professor, "Simulations in Signal Processing," *Modeling and Simulation*, Instrument Society of America, 20, 5 (March 1991), 1895-1903.

The capabilities of receiver structures can be greatly enhanced by filtering the received signal. This will increase the signal-to-noise ratio, and in radars and communications systems will increase both the range and the clarity. In these simulations an integration (or framing) process and a low pass

filtering algorithm decrease the random noise in the signal due to transmission through a channel. The simulation takes advantage of a high-level programming language, Matrix Laboratory or MATLAB. In this language it is easy to use algebra and calculus on the matrices and vectors associated with the simulation.

KNOWLES, Kenneth A., Professor, "Rapid Numerical Computation of Functions of Central Moments in Binary Digitized Images," *Proceedings of the Twenty-second Annual Pittsburgh Conference on Modeling and Simulation*, 22, 5 (May 1991), 2432-2439.

Functions of the central moments of objects within binary digital images are utilized to obtain: object size, object location, object orientation, and at least seven unique parameter measures which are invariant under image translation, rotation, reflection, and scale size. These useful parameters not only provide the basis for uniquely locating the object, but also for statistical recognition of the object. In order to compute these important functions, however, moment computations through order three (a total of ten different moments) must be made for every pixel within the boundary of the object. This computational load can exceed the capacity of many computers, especially for high resolution digital images (512 by 512 pixels and greater) obtained at high rates (30 frames per second). As a result, less powerful digital descriptors often must be utilized. A method is presented to greatly reduce the computational load for computing central moments of binary digital images, thus speeding up the process by a factor of 100 or more for high resolution images. Examples of the computations are presented.

KNOWLES, Kenneth A., Professor, "Development of Advanced Instructional Robotic Systems Laboratory Hardware and Software," U.S. Naval Academy Instructional Development Program Report, 30 January 1992.

During the 1991 summer intersessional period the researcher developed PC-based control of the two high performance PUMA industrial robots, located in the Weapons and Systems Engineering Advanced Robotics Laboratory. This permitted the integration of vision and complex multi-robot task controls for robotics course exercises, advanced student projects, and demonstrations. The two PUMA arms were connected, via a PC link, to two kinematically similar telerebotic master controllers.

SMALL, Robert H., Visiting Professor, "Simulation of Naval Combat Systems," *Proceedings of the Twenty-second Annual Pittsburgh Conference on Modeling and Simulation*, 22, 5 (May 1991), 1904-1913.

A method for modeling warfare scenarios is presented. Tactical battle problems can be analyzed using principles from a variety of engineering disciplines. A representative combat system situation (a destroyer gun mount engaging a missile firing gun boat) is presented, which is then modeled and analyzed.

WATTS, Jerry W., Associate Professor, "A First Order Lag Heat Exchanger Model with Varying Time Constants," *Proceedings of the Twenty-second Annual Pittsburgh Conference on Modeling and Simulation*, 22, 4 (May 1991), 1921-1928.

A fast dynamic heat exchanger model is developed using temperature nodules that behave as first order lags. There are four nodules, one relating each inlet temperature to each outlet temperature and each governed by a first order lag, but with time-varying time constants. The equations for the values of the time constants, which must be calculated at each time step as the transient proceeds, are obtained by a method different from that used by previous workers. Kays and London normalized transient curves are used to perform an optimization fit of several parameters in an arbitrarily chosen equation structure. The final

equations for the four time constants provide normalized transients very close to the Kays and London curves. Actual transient curves obtained from an ACSL simulation model which uses the developed equations are presented with Number of Transfer Units (NTU) as a parameter.

WICK, Carl E., Assistant Professor, "Use of An Illumination Model in the Recovery of Blood Vessel Topography from Human Bulbar Conjunctiva Images," *Proceedings of the Twenty-second Annual Pittsburgh Conference on Modeling and Simulation*, 22, 5, (May 1991), 2440-2448.

The bulbar conjunctiva, or the "white area" of the eye is a unique site where blood flow in the smallest of the body's blood vessels may be easily and harmlessly observed. These small blood vessels, referred to as the body's microcirculation system, have proven to be of great value in the study of vascular related diseases. Attaining data from images to do these studies, however, has been principally a manual and labor intensive task. Past attempts to automate the recovery of blood vessel network information from photographs and video images of the conjunctiva have been only partially successful. This paper outlines a model which replicates the illumination processes contributing to a film or video image of the conjunctiva. The model is intended to be used as a basis for the development of improved image processing techniques to recover blood vessel information.

## Presentations

BECHERT, Thomas E., Associate Professor, "Modeling of Dynamic Systems," Twenty-third Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 30 April 1992.

CLEMENT, William I., Assistant Professor, "Generalization Capabilities of Back-Propagation Neural Networks," Twenty-third Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 30 April 1992.

DEMOYER, Robert Jr., Professor, "Parameter Estimation Leading to Closed-Loop Response Prediction in an Undergraduate Servomechanism Course," International Federation of Automatic Control Conference on Advances in Control Education, Boston, Massachusetts, 24-25 June 1991.

DWAN, Terrence E., and Jerry W. WATTS, Associate Professors, "Statespace Control of a Gas Turbine Engine," Summer Computer Simulation Conference, Baltimore, Maryland, 22 July 1991.

DWAN, Terrence E., Associate Professor, "Frequency Shift Keying Simulations in MATLAB," Twenty-third Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 30 April 1992.

DWAN, Terrence E., and Jerry W. WATTS, Associate Professors, "A Model and Statespace Controller for an Inter-cooled Regenerated (ICR) Gas Turbine Engine," 1992 American Society for Mechanical Engineers (AMSE) Turbo Expo - Land, Sea, and Air, Cologne, Germany, 1-4 June 1992.

FERRIS, William F., Commander, USN, "An Academic Exercise in Guided Missile Control System Design and Flight Simulation," Twenty-third

Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 30 April 1992.

KNOWLES, Kenneth A., Professor, and William I. CLEMENT, Assistant Professor, "An Instructional Robotics and Machine Vision Laboratory Station," International Federation of Automatic Controls - Advances in Control Education Conference, Boston, Massachusetts, 24-25 June 1991.

KNOWLES, Kenneth A., Professor, "Acceleration Techniques For Computing Object Parameters From Digital Images," Twenty-third Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 30 April 1992.

RASK, Olaf N., Associate Professor, "The Onset of Buckling in Composite Materials as Monitored by a Fiber Optic Strain Gage," Twenty-third Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 30 April 1992.

WATTS, Jerry W., Associate Professor, "Modeling an Inter-cooler with First Order Lag Time Constants," Twenty-third Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 30 April 1992.

WICK, Carl E., Assistant Professor, "Use of an Illumination Model in the Recovery of Blood Vessel Topography from Human Conjunctiva Images," Fifth World Congress for Microcirculation, Louisville, Kentucky, 2 September 1991.

WICK, Carl E., Assistant Professor, "Use of an Illumination Model in the Recovery of Blood Vessel Topography from Human Conjunctiva Images," 1991 Fall Biomedical Engineering Society Meeting, Charlottesville, Virginia, 12 October 1991.

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## Division of Humanities and Social Sciences





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## Economics

Professor Rae Jean B. Goodman  
Chair

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**D**uring the 1991-1992 academic year, the Economics Department faculty was involved in a wide range of research activities. Professor Kenneth Coffey, the Manpower, Personnel and Training Research Professor, initiated a two-year study of the economic, or opportunity, cost of recalling medical personnel to active duty during the War with Iraq. His analysis is directed at several questions: Will the economic losses of the medical personnel recalled prompt physicians and dentists to leave the Navy Reserve as soon as possible? Will the economic losses impede the Navy's effort to find and retain qualified medical personnel? Other significant research efforts include Professor Bowman's analyses of the U.S. Naval Academy and the Naval Postgraduate School, Professors Little and Fredland's investigation of defense contractor profitability and monopoly power, Associate Professor Gibb's continued efforts in modelling labor markets in less-developed countries, Lieutenant Fiorino's investigation of labor market experience of female veterans, Associate Professor Zak's examination of second source technology transfer and competition, and Assistant Professor Kulchycky's investigation of U.S. direct investment.

The department's history of midshipmen involvement in department research continued with a Trident Scholar and two Honors research projects. The research on U.S. direct investment performed by Midshipman 1/C Andrew Wolff under the direction of Assistant Professor Kulchycky was an extension utilizing dynamic analysis. The Honors Program midshipmen investigated vastly different topics: Midshipman 1/C William Burgess examined the economic characteristics of firms which were



targets of mergers during the wave of mergers of the 1980's; Midshipman 1/C Brian Grubbs investigated the academic performance of midshipmen and admission criteria.

The Economics Department had a very productive year in research with nine presentations at major conferences. Funding support for Economics Department research has come from the Naval Academy Research Council, Bureau of Personnel, and the Defense Systems Management College.

## **Sponsored Research**

### **Cost-Benefit Study of United States Naval Academy**

Researcher: Professor William R. Bowman

Sponsor: Chief of Naval Operations, OP-01

This research is a continuation of a project begun in 1990 to compare the retention-promotion rates of major accession sources in Unrestricted Line communities with the total cost of education and training by sources. The latter include college education and formal training programs during the first ten years of service.

The retention and promotion processes are modeled statistically to estimate the unique impact

of U.S. Naval Academy compared with Reserve Officer Training Corps and Officer Candidate School programs. The higher retention/promotion rates of Academy graduates is then used to determine if initial higher education costs are justified in terms of lower total training costs of its graduates, who are more likely to reach successively higher promotion grades.

### **Cost-Benefit Study of Naval Postgraduate Education**

Researcher: Professor William R. Bowman

Sponsor: Chief of Naval Operations, OP-01 (NAVPERS2)

The main purpose of the project is to determine the most cost-effective means of paying for non-technical graduate education funded by the Navy. The project is in progress, with an anticipated August 1992 completion date.

Individual officer records will be analyzed to compare the prior academic achievements and Navy experience of those attending civilian, as opposed to, Naval Postgraduate School programs. Curricula of

programs and the total costs of education, housing, and pay for each type of program are compared. Finally, the researcher will compare how graduates use their education in sub-specialty billets following graduation.

A final study will be prepared for PERS-2 of OP-01 to help formulate future funding plans for Navy-sponsored graduate education.

### **Economic Cost of Recall: Impact on Navy Reserve Physicians and Dentists Recalled to Active Duty During the War with Iraq**

Researcher: Research Professor Kenneth J. Coffey

Sponsor: Chief of Naval Operations, OP-01

The purpose of the research project is to define and estimate the economic or opportunity cost of recalling 693 Physicians and 74 Dentists to active duty during "Desert Storm" and "Desert Shield," and to evaluate the impact of their active duty service on subsequent professional income levels and on future Naval Reserve service plans. With the degree of reliance already placed on the Navy Reserve for Medical personnel in the event of emergencies, and with the plans to increase the reliance even more, it is critical that Reserve personnel with the

appropriate skills and experience levels be available for recall in adequate numbers. If the economic costs are of a significant "order of magnitude" to deter medical personnel from joining the Naval Reserve, this should be a cause for concern among Navy managers.

The first part of the research project involves analysis of data relating to the 693 physicians and 74 dentists recalled to active duty. During the period of active duty service, about one-third of the recalled physicians and dentists were assigned to the

Middle East war zone. The remaining officers back-filled positions, mostly in U.S. hospitals, that had been vacated by deploying medical personnel. The various factors analyzed include: demographic and military service data, military-civilian earning disparities, and long term impact of recall on post-

service business levels. A survey of the recalled personnel was conducted to confirm forecast data and to provide data on impact on Naval Reserve service. The analysis will focus on whether retention levels meet Navy needs.

### **Civilian Labor Market Experiences of Female Veterans**

Researcher: Lieutenant Susan J. Fiorino, USN  
Sponsor: Naval Academy Research Council (OMN)

While the literature has documented the socioeconomic characteristics and labor force experiences of male veterans, a void exists in similar research for female veterans. The National Longitudinal Survey of Labor Force Behavior provides a unique opportunity to fill this void and to

provide the Navy with information necessary to make informed policies regarding recruiting and retention. Multi-variate statistical techniques will be used to analyze the data. Thus far, only the methodological approach and a portion of the literature search are complete.

### **Defense Contractor Profitability and Tobin's q**

Researchers: Professors J. Eric Fredland and Roger D. Little  
Sponsor: Defense Systems Management College

The profitability of major defense contractors is apparently driven by the size of procurement budgets and by Defense Department policy regulating profit that can be earned by firms doing defense business. The purpose of this research is to examine the extent to which these factors--procurement budget size and profit policy--are reflected in financial market assessments of these firms. The analytical tool used is the q ratio, first developed by James Tobin and now widely used as a measure of monopoly power and as an approach to measuring the relationship between financial markets and capital investment.

The q ratio is the ratio of market value of the firm to the replacement cost of its capital stock. In theory, when the q exceeds one, investment in new capital enhances market value. If a firm is in a competitive industry, q will tend to move to unity as entry and/or expansion leads to exploitation of available investment opportunities. In an industry with significant barriers to entry, however, q will tend to exceed one, reflecting the existence of

monopoly profits. Defense contractors operate in an environment with significant entry barriers. Their profitability is potentially subject to sharp fluctuation, however, when budgets change and perhaps when Defense Department policy regarding contractor profit changes. If these changes in fact affect profitability to any great degree, they should be reflected in fluctuations in the q ratio.

The researchers used the COMPUSTAT data base, which contains financial data on more than 3000 firms over a 30-year period, to carry out this effort. The first analyses have been completed. A time series approach shows a clear relationship between changes in procurement budgets and changes in q ratios for defense contractors, but fails to confirm a relationship between profit policy and q ratios. These results were presented in a paper given at the Eastern Economic Association meetings in New York on 28 March. Work is on-going. Particularly, cross section analysis of samples of individual firms at points where key aspects of policy have changed is now being done.



## **Modeling Labor Markets in Agricultural Growth Linkage Analysis**

Researcher: Associate Professor Arthur Gibb, Jr.

Sponsor: Naval Academy Research Council (OMN)

Recent research on agricultural growth linkages has focused on the question of the supply elasticity of non-farm goods and services. The issue is whether the tightening of rural labor markets causes wages to rise, thus translating into higher prices for non-farm goods and services, which in turn dampens the income multiplier effects of technology-induced agricultural advance. The modeling adaptations needed to account for such supply inelasticities greatly complicate the analysis, increase the data requirements, and reduce the educational value of

such analyses. The researcher postulates that it is possible to simplify the analytics and increase the usefulness of linkage analysis through two steps--spatial disaggregation of the rural economy and, pursuant to this, more detailed specification of labor market conditions. The first step provides the basis for assuming away much complexity; the second increases the educational effectiveness of the analysis, and hence its policy effectiveness.

A paper on this topic is being circulated for comment among specialists.

## **The Differential Effects of Foreign and Domestic Takeovers on U.S. Firms**

Researcher: Assistant Professor Ksenia Kulchycky

Sponsor: Naval Academy Research Council (OMN)

This paper is an analysis of the effects of foreign takeovers of U.S. firms on the operations of those firms. The recent growth in foreign takeovers of American firms has led to many anxious comments in the press, various proposals for registration provisions, and other legislative proposals for restrictions. Fear of foreign takeovers includes anxiety over excessive foreign influence on our economic and political system, foreign acquisition of proprietary technology and shifting of research-and-

development investment away from the U.S., thereby eroding U.S. competitiveness, reducing employment and skill levels of workers, and transfer of high-tech, high value-added, components of production away from the U.S. Despite the concern regarding foreign takeovers, there has been little research done on their effects. The theoretical model is being developed and data gathering has begun. The National Bureau of Economic Research helped sponsor this project.

## **Toward Resolving the Tension Between Theory and Fact: The Determinants of International Direct Investment and Trade**

Researcher: Assistant Professor Ksenia Kulchycky

Sponsor: Naval Academy Research Council (OMN)

The objective of this research is to resolve the contradictions between the theoretical and empirical literature of direct investment. Most of the theoretical literature predicts that direct investment is attracted by differences in relative factor endowments between countries. The empirical literature shows that direct investment is attracted to economies endowed similarly to its parent country. The model developed in this paper proposes that these contradictions are a result of inadequate theoretical and empirical analysis of the issues of internalization. An empirical analysis of the Kulchycky model, which merges internalization and location choice issues of direct investment, is conducted. Tobit and Logit analyses were used to

determine whether the new modeling of direct investment was supported by the data.

A unified approach to the understanding of direct investment led to the derivation of different measures for the two distinct aspects of direct investment. One group of measures focused on issues of internalization, another on location considerations. The results of the analysis strongly support the view that internalization issues are central to any understanding of direct investment. They further demonstrate that location choice is affected by factor endowments, as predicted by theories of comparative advantage. In order to observe those results, however, it is first necessary to specify properly the influence of internalization.

Consistent with the implications of the Ethier model, internalization was found to be positively related to similarity in relative endowments and firm research-and-development intensity. At the same time, consistent with the theory of comparative advantage, overseas production (adjusted for internalization) was negatively related to relative

endowments. The empirical findings presented in this paper therefore confirm in important ways the traditional explanation for multinational investment, and the more recent theory which focuses on the issues of internalization. This research was also sponsored by the National Bureau of Economic Research.

### **Technology Transfer and Opportunism in Second-Source Defense Contracts**

Researcher: Associate Professor Thomas A. Zak

Sponsor: Defense Systems Management College

This research examines how product, producer, and customer characteristics affect second source technology transfer and competition. Initial modelling has focused on the effect of producer characteristics on technology transfer and competition. In particular, the better the technical match between the firms, the more likely the technology will be transferred. This raises questions about the likelihood or success of collusion between contractors when required second source technology transfer takes place. When the firms are not exact technological matches, then it appears that compar-

ative advantage between firms arises. Other factor prices (e.g. wages) and the quality of other inputs dictate which of several possible transfers will take place.

Low productivity, low wage firms will acquire more obsolete technologies. Once again this raises concerns about similar cost structures and the potential for collusive behavior. All of the above results derive from assuming a homogenous product. The next step is to try to incorporate elements of product heterogeneity and complexity.

### **Dynamic Analysis of U.S. Direct Investment**

Researcher: Midshipman 1/C Andrew D. Wolff, USN

Adviser: Assistant Professor Ksenia Kulchycky

Sponsor: Trident Scholar Program

The focus of this study proceeds along the lines of Kulchycky (1990) by suggesting that there are two separate components to U.S. direct investment. Firms invest after considering issues of both internalization and location choice. Models of direct investment by Ethier (1986) and Helpman and Krugman (1985) that have seemingly contradictory predictions for the relationship between relative endowments and direct investment are analyzed. These models are viewed as complementary in this model, however, because they each affect direct investment behavior in a different way (i.e., internalization and location choice). It is hypothesized that once internalization is controlled

for the effects of relative endowments on location, choice will be observed. Thus, issues of internalization are assumed to be critical. This and other predictions are tested for 1966 and 1989 in order to lend further support to Kulchycky's 1982 results, which were the first to test empirically internalization predictions. Several variables that were not included in Kulchycky's study are analyzed.

Bowen (1983) showed that changing relative endowments had important effects on the pattern of international trade. This study proceeds one step further and analyzes how changes in endowments and the other variables mentioned above affect changes in direct investment over time.

## Independent Research

### Earnings of Foreign-Born Wives of Servicemen

Researchers: Professors J.Eric Fredland and Roger D. Little

The decision to migrate is largely driven by economic opportunity, and studies generally find that migrants, in time, do well in their new location, suggesting that they are a self-selected group with high motivation. Presumably, the foreign-born wives of servicemen migrate for reasons other than economic ones. They, therefore, provide an interesting group to analyze from a labor market perspective.

This study compares a group of foreign-born wives of servicemen with a group of native-born wives, using a human capital model with selectivity corrections. The results show some evidence of difficulties in adjustment to the U.S. labor market

for these women. Relative to native-born military wives, the labor force participation of foreign-born military wives is lower, small, and statistically significant. Those foreign-born wives who work for pay, however, appear to earn as much as their native-born counterparts. If there are cultural/social barriers which tend to keep their earnings low, we have not uncovered them. It appears that those who find work are able to assimilate quite rapidly into the workplace. The paper which presented these results at the biennial conference of the Interuniversity Seminar on Armed Forces and Society in October 1991 will be re-worked, because it holds promise for publication.

### Rural Non-Farm Employment: Defining a Sector Functionally and Spatially

Researcher: Associate Professor Arthur Gibb, Jr.

This research is a review of the literature on rural non-farm employment in developing nations. It was prepared for the Employment and Development Department of the International Labour Office (ILO), a United Nations agency based in Geneva. Employment in non-agricultural activities in rural areas in the typical developing nation accounts for as much as three-quarters of total non-agricultural employment but has been an ill-defined variable. This research reviews the available evidence in order to establish the magnitudes of the consumption, production, and public service linkages of such employment to agriculture. It also distinguishes its location in terms of core, periphery, and "urban shadow" rural regions. The evidence on how various public policies influence rural non-farm employment is also reviewed.

The review concludes that indirect policy measures are more important than direct ones as influences on rural non-farm employment growth.

Specifically, the price policies which influence farm incomes and the policies which promote agricultural growth, and hence farm incomes, are the primary policy measures. Other key policy areas include measures to assure the smooth flow of supplies to the rural economy and the optimal development of roads, irrigation systems, and small market towns. It is recommended that systems for collecting employment statistics be modified to produce data series able to reflect the impact of such policies on rural non-farm employment generation.

A first draft was completed in June 1990. Detailed comments were received from the ILO in August 1990. The final revision was completed in March 1992, based on those comments and information received at the Austin meeting attended in October 1991. The study will be published as a monograph by the International Labour Office, Geneva, which helped sponsor this project.

### Examination Performance and Incentives

Researchers: Professor Rae Jean B. Goodman and  
Associate Professor Thomas A. Zak

The fundamental hypothesis is that providing a monetary incentive stimulates student performance on a standardized exam. The data used for the analysis are the performances of midshipmen first class economics majors on the Major Field Achievement Test for the 1989-1991 period. The experimental setup was to divide the class into separate classrooms, matching the academic quality of the two rooms by QPR rank. As students entered the "incentive" room they were given a memorandum which informed them that there were monetary prizes for the top three performers by four QPR groupings. Students in the other room

received the same memorandum as they exited the exam. The empirical analysis tests the hypothesis that student performance is sensitive to the prizes. Ability measures that include economics QPR, overall QPR, SAT scores, performance in intermediate macroeconomics and microeconomics courses, and the number of economics courses completed are used to separate the effects of ability from the incremental effort resulting from monetary incentives. The analysis has not been completed; however, the plan is to complete the research during the intersessional period.

### Direct Investment Behavior Toward Developing Countries

Researcher: Assistant Professor Ksenia Kulchycky

With the emergence of independence, Eastern European countries are faced with a host of problems, how to spur development being a major one. Enticing direct investment is often considered an important step to promoting growth in developing countries. The success, or lack thereof, of developing countries in enticing investment, how it was done, why it was, or was not, successful, and what were the results for the country are among the issues that will be addressed in this paper. In particular, the analyses of what happened in other

countries will be compared and contrasted to conditions in Ukraine, to see what relevance they may have. Recent developments in direct investment in Eastern Europe will be compared and contrasted to the Latin American and Newly Industrialized Countries' experience and to Asian communist countries, such as Vietnam, which are attempting to spur growth and investment and create free market zones without changing their political systems. It will conclude with specific policy recommendations for the Ukraine.

## **Schools of Economic Thought in American Graduate Education: The Case of Wisconsin and Chicago**

Researcher: Professor Clair E. Morris

The purpose of this research was to explore the nuances of schools of economic thought in the tradition of graduate economic education in twentieth-century America, in particular the "Wisconsin School" and the "Chicago School." The University of Wisconsin and the University of Chicago offered students distinctly different options when it came to the economics discipline, and this research was directed toward discovering and elaborating those distinctions. The objective was to build on previous research which had been done relative to the characteristics of the founding fathers of the respective departments of economics at the two universities.

A paper presented to the Eastern Economic Association in Pittsburgh in the spring of 1991 on the founding characteristics of the Wisconsin and Chicago Schools was the starting point. Many relevant and significant comments had been received on that paper, and this research project was directed toward expanding an aspect of that report. Exploring the works of Richard T. Ely, J. Laurence Laughlin, and the students of these two prominent teachers, provided the most rewarding insights.

This project needs about one more summer's work to get it in the form of a paper for submission to a specialized journal.



# Research Course Projects

## Characteristics of Merger Targets

Researcher: Midshipman 1/C William E. Burgess III, USN

Adviser: Associate Professor Thomas A. Zak

The large merger wave that hit the United States during the 1980's focused renewed attention on public policy issues ranging from antitrust to securities law enforcement. By examining the characteristics of merger targets, one may gain insight into the underlying motives and thus, perhaps improve the policy responses to mergers and takeovers. This paper empirically examines a broad range of characteristics for U.S. manufacturing firms involved in mergers from 1959 to 1985. The profitability of merger targets is emphasized in a predictive model that estimates the effects of different characteristics upon the probability of any firm being acquired through merger.

In general, merger motives fall into three categories: "synergy," "managerial discipline," and "market power." Each of these has important implications for the potential economic efficiency of

takeovers. Unfortunately, the COMPUSTAT data set is insufficiently rich to indicate unambiguously the relative empirical importance of the different motives. Indeed, a general theory should incorporate all three cases.

Using probit techniques, no broad statistical support was found for the notion that merger targets are differentially inefficient (i.e., below average profitability for their respective industry). At the same time, one cannot statistically reject the hypothesis that targets enjoy above average profits. Individual characteristics that have significant effects on the probability of being acquired include: firm size (-), Tobin's q (+), retained earnings (+), long term debt (+), and the price/earnings ratio (-). A given firm's research-and-development intensity does not have a significant effect on the probability of acquisition.

## Differential Academic Performance and Admission Standards at the U.S. Naval Academy

Researcher: Midshipman 1/C Brian D. Grubbs, USN

Adviser: Associate Professor Thomas A. Zak

U.S. Naval Academy officials have grown increasingly interested in the relative performance of identifiably different groups within the brigade of midshipmen. Almost all of the research to date has been flawed by focusing on only a single characteristic (e.g., gender). This ignores the multitude of factors that affect academic performance. Using multivariate regression, one is able to control for a large number of individual characteristics and improve on results obtained by comparing group averages.

An educational production function using cumu-

lative grade point average as the output (academic performance) and measures of effort and ability (verbal and math SAT scores, high school rank, academic preparation beyond high school, varsity sports participation, major, and ethnic and gender variables) as inputs is estimated. The paper also examines the effect of race and gender on whole-person multiples when controlling for the effects of SAT scores, varsity sports participation, high school rank, and post-high school academic preparation. The use of confidential data prevents the reporting of empirical results here.

## Publications

LITTLE, Roger D., Professor, co-author, "Tied Migration and Returns to Human Capital: The Case of Military Wives," *Social Science Quarterly*, 73, 2 (June 1992), 324-339.

The frequent rotation of military personnel provides a unique opportunity to study the consequences of tied migration on a group of women whose moves

are anticipated and largely independent of economic forces. Possible consequences include reduced labor force participation and hours of work and lower returns to various forms of human capital investment. The analysis confirms these consequences and suggests that a three- versus six-year rotation policy reduces military wives' earnings by 40 percent.



## **Presentations**

**BOWMAN, William R., Professor, "Cost Effectiveness of Service Academies: Case Study of the Naval Academy in Selected Communities," Inter-University Seminar for Armed Services Bi-Annual Meeting, Baltimore, Maryland, 13 November 1991.**

**BOWMAN, William R., Professor, "College Education, Job Turnover, and Work Performance in the U.S. Navy," Twenty-second International Atlantic Economic Association Meeting, Nice, France, 7 April 1992.**

**FREDLAND, J. Eric, Professor, "Earnings of Foreign-Born Wives of Servicemen," Biennial Meeting of the Inter-university Seminar on Armed Forces and Society, Baltimore, Maryland, 11-13 October 1991.**

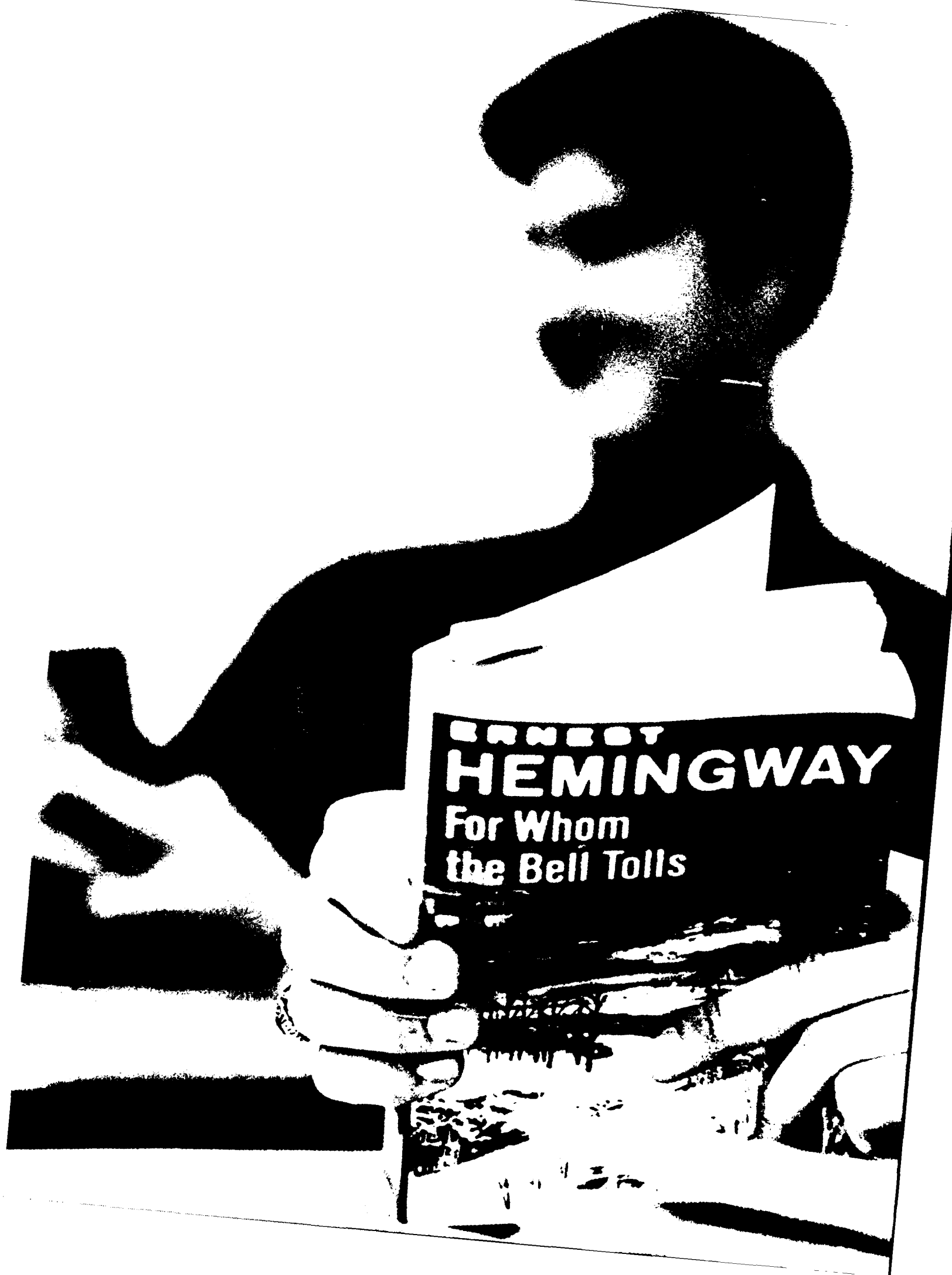
**FREDLAND, J. Eric, Professor, "Defense Contractor Profitability and Tobin's q," Annual Meeting of the Eastern Economic Association, New York, New York, 27-29 March 1992.**

**KULCHYCKY, Ksenia, Assistant Professor, "Toward a Resolution of the Conflict Between Theory and Fact: The Determinants of International Direct Investment and Trade," Eastern Economic Association Meeting, New York, New York, 28 March 1992.**

**KULCHYCKY, Ksenia, Assistant Professor, "Direct Investment Behavior Toward Developing Countries," International Ukrainian Economic Association, Academy of Sciences of Ukraine, Kiev, Ukraine, 18-21 May 1992.**

**ZAK, Thomas A., Associate Professor, "Cutting the U.S. Defense Budget: The Implications for Trade and Competition," Research Unit in Defense Economics Conference "Defense Contracting in the UK and USA: Key Issues for the 1990's," Bristol, England, 21 June 1991.**





ERNEST  
**HEMINGWAY**  
For Whom  
the Bell Tolls

# English

Professor Charles J. Nolan, Jr.  
Chair

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Again this year English Department faculty members were extraordinarily productive, publishing several books and a number of journal articles and giving a variety of conference papers. Assisted by institutional support, department scholars worked in diverse areas. Specific topics supported by the Naval Academy Research Council included historical-cultural studies in eighteenth-century and early twentieth-century British literature and contemporary American fiction, as well as literary criticism treating various genres. Instructional Development projects focused on computer-assisted pedagogy in composition, Naval correspondence, and Shakespearean drama. In addition, independent research covered a wide spectrum of topics, ranging from instruction in creative writing (a textbook) to its varied practice (poems, short stories, and a novel). Other scholars investigated local history, fictional themes, and Victorian literature. Midshipman research directed by faculty members complemented these efforts; five English majors completed significant projects in literary studies.

Earlier research also came to fruition this year. Two books were published; two more are forthcoming; and almost two dozen scholarly articles, creative works, and reference essays were printed. Faculty members also presented conference papers at an average rate of three times a month throughout the school year. The kind of paradigm this work reflects--self-generated efforts that are supported by institutional funding and that culminate in published work or conference papers --keeps the department vital and effective in its support of the Naval Academy mission. In the end, all of our research and publication focuses ultimately on one objective--the very best education for midshipmen.



## Sponsored Research

### Postcards from the Trenches: Negotiating the Space between Modernism and the First World War

Researcher: Assistant Professor Allyson Booth  
Sponsor: Naval Academy Research Council (OMN)

The researcher is working on a project about the relationship between modernism and World War I. Though many of the literary works now identified as distinctly modernist were produced during war years, few of them are the expression of soldiers. Thus, the gap between soldier and civilian--one of the most complicated features of the relationship between literary modernism and cultural history--

structures this investigation, the attempt to understand both how modernists responded to World War I and the various ways they protected themselves from its grisly details. Throughout the research, the focus is on how both literary and architectural modernism participated in a culture shaped and traumatized by war.

### No Deposit, No Return: the Cap and Bells in *Hamlet* and *Endgame*

Researcher: Assistant Professor Anne Marie Drew  
Sponsor: Naval Academy Research Council (OMN)

The title above labels a completed essay which is part of a larger work, a collection of critical essays in analysis of the many and various connections between the dramatic works of William Shakespeare and Samuel Beckett. The researcher continues to

compile materials and pursue evidence relevant to this conjunction. As the project reaches fruition, the author will submit the manuscript under its working title, "Past Crimson, Past Woe: the Shakespeare-Beckett Connection."

## NavCorr

Researcher: Professor Philip K. Jason  
Sponsor: Naval Academy Instructional Development Advisory Committee

This project was an effort to make the printed conventions of Navy Correspondence more readily available to those doing their work with computer word processing programs. Thus, "NavCorr" is a software reference and tutorial for naval correspondence. In its initial, recently-completed version, the format conventions and related information about naval correspondence are now

available in a preliminary demonstration version of the program. "NavCorr" was written with XText, a hypertext compiling program developed by Flambeau Software. "NavCorr," which can now be used as part of appropriate course units or independently of coursework, is memory resident and context sensitive. It works as a help program with any IBM-compatible word processor.

## **Critical Perspectives on Anais Nin**

Researcher: Professor Philip K. Jason  
Sponsor: Naval Academy Research Council (OMN)

This work will trace, describe, and assess the body of critical opinion responsive to Anais Nin's writings from the 1930's to the present. The researcher envisions the following format as the organizational outline of his documentation: the introductory chapter will formulate the main critical issues of genre, intention, and affinity. Another chapter will provide overviews of bibliographical, biographical,

and comprehensive studies of essay length. Subsequent chapters will treat published commentary more narrowly focused on Nin's own critical writings, her short fiction, her novels, and her multi-volume *Diary*. The concluding chapter will sum up the main trends in Nin criticism and attempt to understand them in terms of changing critical fashions, as well as Nin's own growth as an artist.

## **Shakespeare on Computer: An Instructional Program for Students in Various English Courses**

Researcher: Professor Michael Jasperson  
Sponsor: Naval Academy Instructional Development Advisory Committee

To enhance the teaching of courses in Shakespeare, a computer program that provides information on the playwright's biography, the historical period, and the three major drama genres should be of significant value to students. Work on this project has thus far focused on the history play genre of Shakespeare's canon. A completed demonstration version of the program now includes extensive information on the chronology of historical events depicted in four of the history plays. By activating

hypertext links, the student can move freely between the actual historical events and the characters who enliven the dramatized versions of those events. Additionally, extensive information on each of these characters is available in the menu-driven format. As a tutorial program, this instructional supplement will be made available to students; additional programs on other aspects of Shakespeare studies should follow.

## **Edit-It**

Researcher: Professor Allan B. Lefcowitz  
Sponsor: Naval Academy Instructional Development Advisory Committee

Using MATRIX LAYOUT, a hypertext program writer that enables the user to create stand-alone programs, the researcher is developing software to help students enhance their abilities to edit their own writing by leading them to identify and propose solutions to high-frequency problems in rhetoric, grammar, and mechanics, as those problems appear in the context of sentences and paragraphs. MATRIX LAYOUT enables the programmer to join databases containing whole texts and/or visuals in windows that can be presented sequentially to the student. Writing problems can be presented, students can select problem sentences and/or para-

graphs, rewrite them, and then view comparisons ("answers") to their edited sentences to see if their proposed solutions are reasonable.

Instructors can target individual students for work on a specific weakness, rather than devoting class time to a discussion of some principle or error pertinent to only a few students. The major thrust of the project, then, is to exploit the three-dimensional potentials of the computer to create opportunities for active rather than passive instruction in basic writing skills. The project continues, approximately 50% complete.

## **The Publishing History of William Lily's Latin Grammar, 1600-1800**

Researcher: Assistant Professor Nancy A. Mace  
Sponsor: Naval Academy Research Council (OMN)

William Lily's *A Short Introduction of Grammar* is an important work for English scholars, because it is a reliable source of Latin quotations familiar to seventeenth- and eighteenth-century readers. Consequently, this reference work can assist moderns in determining which Latin authors were popular during this period of literary history. As one of the most valuable royal patents for printing from the late sixteenth century until the nineteenth century, the fortunes of the grammar patent can also provide new information about the publication process, the events that led to the first copyright law, and the relations among various groups involved in granting monopolies on books--the mon-

arch, the Star Chamber, the Stationers' Company, and the universities.

Although most scholars have assumed that the text of the grammar and the terms of the patent remained the same for three-hundred years, a close study of the text and official documents relating to the patent history demonstrates that the grammar and the patent in which it was listed underwent many substantial changes over its history. The goal of this project was to ascertain exactly the nature of these changes and to relate them to significant historical and educational developments during this period.

## **Exploring the Novel**

Researcher: Professor David O. Tomlinson  
Sponsor: Naval Academy Instructional Development Advisory Committee

This project follows the pattern of a previously-developed program to assist in the presentation of historical materials to supplement instruction in the study of literature as applied to the teaching of critical analysis and basic composition. That earlier program dealt with drama; this work includes a variety of materials about the history of the novel, as well as information about the conventions and techniques of the genre. Like all hypertext pro-

grams, this one permits students to explore the available materials by choosing their own pathways through it. The result is that students can gain comprehensive views of a field quickly and accurately. Use of this program, either by individual students in a tutorial or self-teaching mode, or by instructors in the classroom, should help midshipmen broaden the scope of their learning beyond the limits of ordinary classroom teaching.

## **The House as Central Image and Symbol in Mary Gordon's Fiction**

Researcher: Associate Professor Eileen Tess Tyler  
Sponsor: Naval Academy Research Council (OMN)

Mary Gordon is a highly-acclaimed writer of contemporary American fiction. Writing from a strong Irish-Catholic background, Gordon has explored in her four novels and many short stories human love and its limitations and the familial, religious, and cultural legacies impinging upon American individuals and communities. All of Gordon's fiction is bound together by one crucial image that comes to have considerable symbolic import--the image of the house. This ongoing long-

term project will demonstrate the many ways in which houses and the idea of shelter are integral to Gordon's entire canon, including such diverse elements as style, settings, themes, characterization, and plot structures. The research and analysis will also place Gordon's fiction in the contexts of Roman Catholicism and of the novelistic tradition of fiction by and about women, showing how this author draws from those traditions in her emphasis on houses and shelter.

## Independent Research

### *Joie de Livre: Living by Poetry*

Researcher: Associate Professor Nancy P. Arbuthnot

This collection of personal, reflective essays examines the importance of poetry in the author's life. Chapters include essays on teaching poetry to young children, emphasizing the importance of empowering our children with language that is rhythmic and graceful; teaching poetry at the Naval Academy; translating poetry; writing poetry; being

part of a community of writers; and an essay on the life-long experience of being a reader of poetry. As the work has progressed, several of the essays have been published or presented as papers at professional conferences. Two chapters remain to be written.

### **Jilted by Jesus: Religious Faith Lost and Found in Modern American Literature**

Researcher: Professor Fred M. Fetrow

The project is an exploration into the theme of religious apostasy and/or conversion as manifest in modern literary texts. One version of the theme entails the disillusionment of either a true or would-be believer in the promise of Christ's comforting presence according to the traditional reading of the scriptures. Characters in these stories, poems, and novels either have their faith tested or even shaken, or lose their belief altogether, because their personal and cultural expectations of the power of faith are unfulfilled or thwarted. Another major rendering of the theme involves the acquisition or strengthening of faith, due to a dramatic or emotional experience in the life of the protagonist.

Finally, a few works complete the circle by showing characters in full transition from blind, misplaced faith to disillusioned skepticism, to renewed or enlightened "mature" views of Christ and religion. Not surprisingly, many of these stories address this issue in the context of crisis--young people, adolescents finding or losing initial faith, the elderly in the face of death assessing the worth of their lifelong commitment to a God who seems to be abandoning them. The variations on this theme illuminate the stories and the poems themselves, but the collective study serves as a commentary also on the cultural antecedents for the views of reality presented.

### **The Resolution of Grief in Walker Percy's *The Second Coming***

Researcher: Associate Professor Mary D. Howland

The researcher is reviewing current literature on the grief process in order to understand how Will Barrett (Percy's protagonist in *The Second Coming*) works through his memories of the events that led up to his father's suicide. The ambiguous ending of *The Last Gentleman*, the first Percy novel in which Will Barrett appears, suggests that Will has not re-

solved, or even acknowledged, the grief he experienced as an adolescent. In *The Second Coming* a middle-aged Barrett, having reached the age of his despairing father, comes to terms with memories that lead to an understanding of his father's choice.

## A History of Presidents' Hill in Annapolis

Researcher: Professor Michael P. Parker

The area of Annapolis now known as Presidents' Hill lies between West Street, Taylor Avenue, and the old Baltimore, Washington, and Annapolis Railroad right-of-way. It consists of four streets: Munroe Court, Madison Place, Hill Street, and Jefferson Place. The neighborhood was first developed by the Brewer family in the early 1890's as a fashionable suburb of Annapolis; the crash of 1893, however, sent real estate prices plummeting, and the remainder of the lots were developed on a less pretentious scale. In the early 1900's Presidents' Hill was the home of many small businessmen and craftsmen, including some who went on to become significant forces in the Annapolis commercial community. Two mayors of Annapolis lived in Presidents' Hill; another, current mayor of Annapolis Alfred A. Hopkins, has close

family links to the community. The neighborhood began to change dramatically in the 1960's as the traditional family and social networks that held it together eroded; the availability of Title 8 low-income housing funds led to a marked increase in rental property in the neighborhood. In 1984 Presidents' Hill was included in the Annapolis Federal Register Historic District, and it has increasingly become subject to gentrification of the last decade. This history will trace the chronicle of Presidents' Hill from its founding up to the present day, relying on interviews with long-time residents, newspaper accounts, and property records. A building-by-building survey of the community's architectural and historical landmarks will complement the narrative.

## The Creative Process

Researcher: Professor Molly B. Tinsley

This work, scheduled for publication in the fall of 1992, applies the process model of composition teaching to the teaching of creative writing. The authors (Dr. Carol Burke, a former member of the Naval Academy English Department, is co-author) emphasize three stages in the creative process: (1) generating material by means of sensory perception,

memory, and imaginative invention; (2) making preliminary decisions about technique in order to enhance tension, create concrete images and scenes, and develop metaphorical levels, and establish a viable point of view; and (3) working toward final shape by attending to form and genre.

## Discernment in Victorian Literature

Researcher: Associate Professor Eileen Tess Tyler

This study examines the presentation of how moral and vocational decisions are made in Victorian literature, and relates these literary renderings to their roots in the literature of Christian discernment. Tennyson's *Idylls of the King*, for example, and the fiction of Charles Dickens and

Charlotte Bronte are deeply rooted in this tradition. Special attention will be given to the psychological dimensions of discernment--especially in the depiction of desolation and consolation--and to the angelic and demonic iconography associated with discernment.

## Songs in the Night

Researcher: Professor John Wooten

This creative writing project, begun in the summer of 1991, is approximately half completed. The author hopes to complete the initial draft by the end

of the 1992 intersessional. The project is a mystery novel set in South Carolina in 1966. Response by colleague readers has been very encouraging.

## Research Course Projects

### Faith and the Comic Vision in Flannery O'Connor, T. S. Eliot, and Evelyn Waugh

Researcher: Midshipman 1/C John D. Eydenberg, USN  
Adviser: Associate Professor David A. White

Prompted by a personal search for anchors of meaning in twentieth-century literature, this project draws parallels between the philosophical development of Evelyn Waugh and T. S. Eliot toward a belief in the capacity of man to achieve grace. Both authors began their careers as epitomes of the modern, existential voice. They then proceeded along remarkably similar paths: recognizing the possibility of a divine force, detailing

the life of a martyr toward grace, and finally, finding comedy in the average man's capacity to gain God's grace. After tracing the developmental stages of these two authors, the researcher then examines their later works, especially Waugh's *Brideshead Revisited* and his World War II trilogy and Eliot's *The Cocktail Party*, and unites their common comic vision with that of Flannery O'Connor in her stories in *Wise Blood* and "A Good Man is Hard to Find."

### Viewpoint (a short story)

Researcher: Midshipman 1/C Julianne J. Gallina, USN  
Adviser: Professor Molly B. Tinsley

The researcher first studied "voice" in personal narratives by reading extensively in literature chosen for its tone and perspective, with an eye toward defining the tone of the final short story. All of the works read were narrated by women who related family experiences. These examples all conveyed a similar progression from innocence to wisdom.

The author's version of this format, titled "Viewpoint," relates the experience of a young girl

who witnesses the crumbling of her parents' marriage and recalls the events leading to her father's murder. Her concern for fire safety in the home becomes a metaphor for her concern for the family's emotional security and her father's well-being. The goal of this project was to create a narrative that captured the innocence of a child who is also sophisticated enough to discern the signs which reveal the instability of her family.

### Ted Hughes's *Cave Birds*; A New Religion

Researcher: Midshipman 1/C Peyton B. Hutton, USN  
Adviser: Assistant Professor Allyson Booth

In *Cave Birds: An Alchemical Cave Drama* (1978), Ted Hughes dramatizes the incomplete development of Western man's inner being, a shortfall resulting from man's having turned away from nature towards Christianity. Though the collection shies away from the stark gender polarities outlined in such earlier works as *Crow* (1970), the female in *Birds* is still the figure associated with primal nature, while the male reaps the benefits of coming to terms with that female energy.

Hughes in this "drama" thus creates a new religion which revolves around the earth as a life principle. The sun in such an allegory appears as a

female bird who accuses the speaker of having neglected her and the natural forces she represents. Due to this confrontation, and after a struggle, the speaker decides to abandon the religious conventions that have prompted his repression of violence and his sanitation of death; he thus brings his inner and outer selves into harmony with each other. The newly-integrated self, symbolized by a solar eagle, suggests Hughes's apparent conviction that if we were able to tap into the chaotic impulses that religion conceals and denies, we would have access to a profound if primitive power.



## **The Making of Men: Internalization of Value Structures and the Masculine Identity**

Researcher: Midshipman 1/C David N. Newcomb, USN  
Adviser: Associate Professor Laura Claridge

Prompted by the current wave of the Men's Movement, and using ideas advanced by Nancy Chodorow on the role of the father in male development, as well as considering the notions of Deborah Tannen on the defining differences of gender, this researcher investigated the distinctly gendered phenomenon of male coming-of-age. This progression is usually divided into three stages: first, a rejection of parentally or societally imposed values of identity; second, a struggle and a search for a new value system; and finally, the internalization of

a value structure as a man's own, this final stage marking the passage or transistion to achieved manhood. This basic paradigm is used to examine literary manifestations of the phenomenon, such works as D. H. Lawrence's *Sons and Lovers*, E. M. Forster's *Maurice*, and St. Augustine's *Confessions*. These and other fictional versions of truth shed much light on the male coming-of-age transition as both a functional and dysfunctional experience in the lives of men both real and fictional.

## **The Development of Folk Drama in North Carolina**

Researcher: Midshipman 1/C Pamela L. Plyler, USN  
Adviser: Associate Professor Robert D. Madison

Before 1918 the American theater had not developed a style of its own. In that year, however, Professor Frederick H. Koch came to the University of North Carolina at Chapel Hill to begin a program of teaching playwriting to undergraduates. George Pierce Baker had done the same thing with his "47 Workshop" at Harvard, but Koch's program was unique, in that it emphasized writing about folk life, something with which the North Carolina students were very familiar. Among Koch's first students were the later famous novelist Thomas Wolfe and playwright Paul Green. Green went on

to create the uniquely American genre of symphonic outdoor drama, initially supported by Koch's Carolina Playmakers, a form of drama still attracting more audience than modern Broadway fare. The development of folk drama in North Carolina created the spark the American theater needed to distinguish itself from its imitative past. This study surveys the inception, development, and influence of the North Carolina folk play, as the author assembles and presents a collection of documents pertinent to its place in and relation to American theater.

## Publications

ARBUTHNOT, Nancy P., Associate Professor, "Cafe Omero, Florence," *New Virginia Review*, 8 (Fall 1991), 247.

The narrator, new to Florence, tries to find a church where a concert of Mozart's music is supposed to take place, but ends up instead in a cafe where couples dine to music of a mandolin.

BOOTH, Allyson, Assistant Professor, "Stevie Smith," *Critical Survey of Poetry*. Pasadena, California: Salem Press, 1992, pp. 3073-3084.

This article traces persistent preoccupations in Smith's poetry, especially the investigation of inherited stories (fairy tales, Biblical narratives, myths) that saturate our cultural imagination. In her exploration of these narratives, Smith uncovers some of the ways in which culture grids us according to both gender and species. Her survey of the positions we occupy within families pays precise and biting attention to instances of ill fit between individuals and the roles in which they find themselves. Animal poems celebrate the possibility of uninhibited if violent life while poking merciless fun at the ways in which human laws and orders trivialize death. Ultimately, she suggests the unattractive possibility that domination is one of our primary (and primal) motivations.

CLARIDGE, Laura, Associate Professor, *Romantic Potency*. Ithaca, New York: Cornell University Press, June 1992.

This book is a sustained study of the creative urges and aesthetic principles of British poets of the early nineteenth-century. In it the author describes the impossibility of language to satisfy the yearnings to which it (language) gives rise. This very unhappiness becomes the psychological scaffold upon which Romantic writers build their ideology of desire and lack.

FETROW, Fred M., Professor, "Proud Ship, Proud Name," *Anne Arundel County History Notes*, 23, 1 (October 1991), 17-18.

The "proud ship" bears the proud name of *Anne Arundel*, an "attack" transport ship commissioned during World War II. This brief article summarizes the history of construction and commissioning, and the war record of the *Anne Arundel*, her crew, and her "live" cargo of U. S. combat troops to the Pacific war zones. Included are the battle stars earned in the invasion efforts aided by this proud ship.

FLEMING, Bruce E., Associate Professor, "The Sweet Smell of Success: A Reassessment of Patrick Suskind's *Das Parfum*," *South Atlantic Quarterly*, 56 (November 1991), 71-86.

The essay considers the successful novel of the German author Patrick Suskind, *Perfume*. Recent essays concerning it in scholarly journals have considered it primarily as a pastiche of Romantic prototypes, considering thereby the texture of the writing and neglecting the work's plot. This essay holds, in contrast, that *Perfume* is most correctly seen not as a Postmodernistic pastiche but instead as a Romantic work, and that this intrinsic Romanticism is clearest through a consideration of the novel's plot rather than its writing style. The analysis considers works by Marcel Proust and Thomas Mann, among other authors.

FLEMING, Bruce E., Associate Professor, "What Makes a Bad Book Bad?," *Southwest Review*, 77 (Winter 1992), 75-85.

The article takes as its point of departure some writings by the American naturalist Frank Norris to delineate possible reactions to literature. These include the reactions that a work of literature is simply bad, that it is interesting, or that it is boring. The philosophical basis of the enquiry is the school of "reader-response" theory developed at the German University of Konstanz. The author finds that the reaction that a work is bad is the result of a violation of a contract of trust that tends to be established between the reader and the literary work. In explaining this concept, the article makes use of some ideas of the French philosopher Jean-Paul Sartre in his essay "What is Literature?." It is possible to have works that are partially or wholly bad, but in each case a rupture of trust is involved.

FLEMING, Bruce E., Associate Professor, "The Voice in My Ear: An Evening at the Kabuki," *New Dance Review*, 4 (January-March 1992), 17-21.

This essay is a consideration of the way Western audience members perceive and react to non-Western art forms, explained through the example of a Kabuki performance at the John F. Kennedy Center in Washington, DC. The thesis of the article is that perception of art works from one's own culture is intrinsically different in practice, if not in theory, than the perception of works of art from

outside that culture. The difference is that works from outside must be perceived without the basis of societal presuppositions taken for granted by members of the culture. Thus these presuppositions must either be filled in--as was the case at the Kabuki performance in question, through the use of a head-set that was rented in the theater lobby--or done without. In the first case, the audience member views what is on stage as an example of a type, rather than as an end itself, which is the way works from within one's own culture would be seen.

FLEMING, Bruce E., Associate Professor, On the Unity of the "I," *Virginia Quarterly Review*, 68 (Spring 1992), 371-376.

This work is a short story that attempts to answer Wittgenstein's perception (cf. *Tractatus Logico-Philosophicus*) that there is no visible location in the world of what philosophers call the metaphysical "I," that is to say the principle linking our perceptions. The story takes the form of a meditation by a character on his childhood, that suddenly seems as far away to him as if it had been the childhood of another person. There is no resolution of the paradox explicitly, though it is suggested that the mere fact of being able to remember the past is what links the past self and the present. Wittgenstein's perception, therefore, is shown both to be correct, and in a sense trivial: though we do not see a link for the "I," we sense it, and this is enough.

GILLILAND, C. Herbert, Associate Professor, "Ken Kesey," *Research Guide to Bibliography and Criticism*, Vol. 6, ed. Walton Beacham, Erica Dickson, and Charles J. Mosely. Washington, DC: Beacham Publishing, 1991, pp. 445-449.

This reference article surveys bibliographical sources and selected criticism pertaining to the life and work of novelist Ken Kesey, author of *Sometimes A Great Notion* and *One Flew Over the Cuckoo's Nest*.

GILLILAND, C. Herbert, Associate Professor, "Marjorie Kinnan Rawlings," *Research Guide to Bibliography and Criticism*, Vol. 6, ed. Walton Beacham, Erica Dickson, and Charles J. Mosely. Washington, DC: Beacham Publishing, 1991, pp. 669-672.

This article, intended as a reference source for students and scholars, surveys and presents biographical sources and selected criticism pertaining to the life and canon of novelist Marjorie Kinnan Rawlings, whose work includes *The Yearling*.

JASON, Philip K., Professor, "Recovering Falconer's *The Shipwreck*," *Journal of Popular Literature*, 5, 1 (Spring/Summer 1991), 81-95.

The enormous popularity during the late eighteenth century and through most of the nineteenth of Falconer's nautical epic is understandable when considering the features of the poem in the larger context of its audience's assumptions. Readers were still hungry for the poetic narrative, though most poets had already turned to meditative or descriptive materials for longer poems. The heroic couplet remained popular even though most efforts by Falconer's contemporaries lacked freshness and immediacy. Falconer exploited these interests while at the same time catching the wave of change from the Augustan interest in the public voice to the Romantic concern with private experience. Moreover, his liberal use of nautical jargon gave the poem an authentic flavor, while his didacticism satisfied an imperative of taste. *The Shipwreck*, perfectly poised between the familiar and the fresh, held its popularity until that very mixture of ingredients began to seem old-fashioned.

JASON, Philip K., Professor, "Robert Peters: Gust and Gusto." *The Great American Poetry Bake-Off*. Fourth Series. Metuchen, New Jersey: Scarecrow Press, 1991.

From his early *The Gift to Be Simple*, based on the life of Shaker founder Ann Lee, to his more recent titles like *Kane* and *The Blood Countess*, Robert Peters has established himself as the foremost practitioner of the dramatic monologue and other types of dramatic poetry. His "voice portraits" usually put before the reader tortured souls, minds inhabited by mania or madness, each needing to risk the limits of flesh or mind. Within the sequences of poems that constitute each portrait, Peters displays a virtuosity of craft and sub-genre. He has mastered various forms and can bend them to the needs of expressing the battle with taboos that lies behind all his work. By recognizing, nurturing, and constantly challenging his special talent and his propensity for the macabre and obscene, Peters has provided an enormous body of work that is certain to last.

LEFCOWITZ, Allan B., Professor, co-author, "Sarah Wyman Whitman: Boston's Renaissance Woman," *Turn-of-the-Century Women*, 5 (Summer 1990), 26-30.

Sarah Wyman Whitman is a neglected figure. She was a promoter of art and artists, including writers, during the last quarter of the nineteenth century. The first female book designer in America, she

rubbed elbows with the major writers of her time—including James Bryce, the Lowells, Henry and William James, as well as the Holmes family. Since she touched the lives of so many prominent contemporaries, one may expect her to turn up in the fiction created during that period, and may reconsider some instances of characterization in those works. She is also significant as a figure who demonstrates once more the role of women in the shaping of American culture.

PARKER, Michael P., Professor, "A Rose for Miss Lucy (and Miss Hessie): Philip B. Cooper and the Hammond-Harwood House," *Anne Arundel County History Notes*, 23, 2 (January 1992), 3 *et passim*.

A heretofore unpublished letter in the possession of Mrs. Cecil Gilmore McKinney of Doswell, Virginia, sheds new light on the development of Annapolis at the turn of the twentieth century and, in particular, on the history of the most famous of the city's homes, the Hammond-Harwood House. The letter of 24 January 1900 from Philip Benson Cooper to his father, former Naval Academy Superintendent Captain Philip Henry Cooper, describes a scheme by the younger Cooper and three associates to buy the Hammond-Harwood House from the aging Harwood sisters and to convert it into luxury apartments. Cooper's partners were a varied and influential group: Annapolis native and Navy football coach Paul Dashiell; the architect George E. Merrill; and the wealthy hotelier and tennis ace William Augustus Larned. According to Cooper family legend, the Harwood sisters agreed to sell their home but eventually regretted their decision; the four tender-hearted businessmen allowed them to back out of the deal. Larned went on to purchase the William Paca House and convert it into the Carvel Hall Hotel, which opened in early 1903. Had it not been for the complex play of personalities and the prevailing gender roles of the period, the scheme to purchase the Hammond-Harwood House would have gone through and the address of Carvel Hall might well have been Maryland Avenue rather than Prince George Street.

TINSLEY, Molly B., Professor, "Square Zero," *American Letters and Commentary*, 4 (Winter 1992), 1-17.

In this short story, a contemporary American "family," consisting of a mother, her daughter, the

daughter's tentative boyfriend, the couple next door, and their two large dogs, gathers to enjoy Christmas dinner together. After a series of understandings and misunderstandings, the mother realizes her involvement in her daughter's lack of motivation.

TYLER, Eileen Tess, Associate Professor, "Mary Gordon," *Magill's Survey of American Literature*. New York: Marshall Cavendish, 1991, pp. 798-809.

This article offers a detailed critical introduction to the four novels of the contemporary American writer Mary Gordon. Opening with a brief biography of the author, the article proceeds to analyze in depth Gordon's ideas and practice as a fiction writer, and then goes on to address each of her novels in turn--*Final Payments*, *The Company of Women*, *Men and Angels*, and *The Other Side*. Particular attention is paid to Gordon's vision of the difficulties of human love and life in various kinds of communities and to the religious dimensions of her thinking.

TYLER, Eileen Tess, Associate Professor, "The Art of Meditative Reading," *EFC News* (Summer 1991), 3-5.

In this essay the author discusses methods of reading that lead towards meditation and contemplation. She addresses the difficulties as well as the benefits of this activity. The article goes on to offer specific suggestions about a wide range of works to read, especially those in the tradition of Christian spirituality, including Scripture, apologetics, ascetical theology, autobiography, and poetry.

WHITE, David A., Associate Professor, "A Bishop for Campos," *The Angelus*, 14 (August 1991), 9-11; "The Consecration in Campos," *The Angelus*, 14 (September 1991), 7-14; and translation, "Antonio de Castro Mayer," *The Angelus*, 14 (July 1991), 2-7.

The writings cited above represent research done by Associate Professor White in writing a forthcoming book on Bishop Antonio de Castro Mayer and the diocese of Campos, Brazil.

## Presentations

BOOTH, Allyson, Assistant Professor, "Barbie Dolls as Monsters, or, How Mattel Shaped the Female Figure and What Todd Haynes Did with It," Northeast Popular Culture Conference, Colchester, Vermont, 11 October 1991.

BOOTH, Allyson, Assistant Professor, "Through a Blue Window: Perception in Katherine Mansfield and Modernist Architecture," Northeast Modern Language Association Annual Convention, Buffalo, New York, 3 April 1992.

CLARIDGE, Laura, Associate Professor, "An Aesthetics of the Beautiful Repressed," Eighteenth-Century Society Meeting, Seattle, Washington, 26 March 1992.

CLARIDGE, Laura, Associate Professor, "Naming and Framing Through the Beautiful," Keats-Shelley Association Meeting, New York, New York, 22 May 1992.

DREW, Anne Marie, Assistant Professor, "No Deposit, No Return: The Cap and Bells in *Hamlet* and *Endgame*," Beckett Festival, The Hague, The Netherlands, 8 April 1992.

ELLER, Jonathan R., Major, USAF, "The Body Eclectic: The Evolution of Ray Bradbury's Martian Chronicles," Northeast Modern Language Association Annual Convention, Buffalo, New York, 4 April 1992.

ELLER, Jonathan R., Major, USAF, "Research Report on *A Descriptive Bibliography of Robert Penn Warren, 1921-1991*," The Robert Penn Warren Circle and Center Second Joint Annual Meeting, Bowling Green, Kentucky, 24 April 1992.

FETROW, Fred M., Professor, "'Time out'a Mind': Charles Johnson's Use of Anachronism in *Middle Passage*," Northeast Modern Language Association Annual Convention, Buffalo, New York, 4 April 1992.

FLEMING, Bruce E., Associate Professor, "Film Theory's Central Myth," Literature/Film Association Conference, Salisbury, Maryland, 25 June 1991.

FLEMING, Bruce E., Associate Professor, "Balanchine as Modernist," Conference on "Looking at Ballet: Ashton and Balanchine 1926-1936," Troy, New York, 12 July 1991.

FLEMING, Bruce E., Associate Professor, "'The Waste Land' and Film Theory," "Narrative" Conference, Nashville, Tennessee, 12 April 1992.

FLEMING, Bruce E., Associate Professor, "Proust and the Power of Solitude," International Association for Philosophy and Literature Conference, Berkeley, California, 1 May 1992.

HILL, John M., Professor, "Transcendental Loyalty in *The Battle of Maldon*," The Battle of Maldon Conference: 1000 Years, Baltimore, Maryland, 10 September 1991.

MADISON, Robert D., Associate Professor, "'Gib a Nigger Fair Play': Cooper, Slavery, and the Spirit of the Fair," James Fenimore Cooper Conference, Oneonta, New York, 12 July 1991.

MADISON, Robert D., Associate Professor, "More Pearls from Orr's Island: Harriet Beecher Stowe's Coast of Maine," American Culture Association/Popular Culture Association Joint Meeting, Louisville, Kentucky, 20 March 1992.

PARKER, Michael P., Professor, "Leaves of Glass: Sarah Eileen Hanley, Louis Comfort Tiffany, and the Modern Movement," American Conference for Irish Studies, Southern Region, Lenoir-Rhyne College, Hickory, North Carolina, 14 March 1992.

PARKER, Michael P., Professor, "Beastly Babes, Mute Messiahs: Millenarian Literature in the English Revolution," International Conference on the Advancement of Learning in the Seventeenth Century, University of Sheffield, Sheffield, United Kingdom, 6 July 1992.

TINSLEY, Molly B., Professor, fiction readings from published novel, *My Life with Darwin*, at the following locations, on the listed dates: Chapters Book Shop, Washington, DC, 11 May 1991; Charing Cross Book Store, Annapolis, Maryland, 12 May

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1991; Borders Book Store, Philadelphia, Pennsylvania, 14 May 1991; Donnel Library, New York, New York, 6 June 1991; Writer's Center, Bethesda, Maryland, 26 September 1991; and University of Maryland, College Park, Maryland, 12 November 1991.

TOMLINSON, David O., Professor, "The Use of the Computer in Teaching Literature: Two Hypertext Programs," Washington, DC, 28 March 1992.





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# History

Professor Craig L. Symonds  
Chair

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During academic year 1991-1992, faculty members of the History Department continued to compile a remarkable record of productivity in their respective scholarly fields. The year was highlighted by the appearance of Daniel Masterson's seminal study of the Peruvian Army, *Militarism and Politics in Latin America*, published by Greenwood Press; Robert William Love's massive two-volume history of the United States Navy, published by Stackpole Press; and Craig Symonds's biography of Confederate General Joseph E. Johnston, published by W. W. Norton.

Associate Professor Masterson's work has received very favorable critical review from historians, political scientists, and from active members of the Federal government. It is a comprehensive study of Peru's military from its founding in the 1930's to the difficulties with the Sendero Luminoso (Shining Path) in the 1980's. A Spanish language version of the book is planned for the near future.

Robert W. Love's *History of the U.S. Navy* appeared in two large volumes early in 1992, and is the result of nearly two decades of careful archival research. Organized by presidential administrations rather than by military conflicts, Love's history focuses as much on the development of American policy as it does on the impact of that policy in battle. The work has drawn critical praise from a wide variety of sources, including former Secretaries of the Navy and CNO's.

Professor Symonds's biography of Joseph E. Johnston is the first in thirty years, and the only account to treat the subject objectively. Johnston was the most controversial Confederate commander of the Civil War. A West Point classmate of Robert E. Lee, he commanded the principal Confederate field army in both its first battle (Bull Run) and its last (Bentonville). But his disputes with President Jefferson Davis led to his dismissal in 1864 after failing to stop the advance of Sherman's Federal army in Georgia.

In addition to these works, History Department faculty members published several other books, authored two dozen articles, and delivered 31 scholarly papers. Particularly noteworthy among



these are Jane Good's co-authored biography of Ekaterina Bresko-Breshkovskaia, Richard Abels' lengthy introductions to two volumes of the Domesday Book project sponsored by the British Museum, Chip Sills' edited two-volume collection of essays on *The Philosophy of Discourse*, and Jack Sweetman's eight articles of naval history.

Midshipmen enrolled in the History Department's Honors program continued to perform excellently. Midshipman 1/C George B. Rowell IV won second prize for the best paper at the Mid-East Regional Phi Alpha Theta Conference in April 1992, and a total of six midshipmen completed the rigorous honors program.

Finally, in recognition of his stellar record of scholarship over the years, Professor Robert Artigiani was nominated as the History Department Researcher of the Year.



## **Sponsored Research**

### **A Question of Will Power: A Comparative Study of the Investigation and Treatment of War Neuroses in England, Austria, Germany, and America, 1914-1922**

Researcher: Associate Professor Theodore W. Bogacz

Sponsor: Naval Academy Research Council (OMN)

This study will treat the impacts of the "shell-shock" crisis on England, Austria, Germany, and America during 1914-1922. The crisis of war neurosis in the First World War had profound implications both for the military and civilian society. A comparative investigation of national responses to this crisis will dramatically contrast differing national attitudes toward such fundamental questions as the diagnosis of mental illness and its treatment, the degree to which men are morally responsible for their acts, and ultimately, definitions of bravery and cowardice

in war. Such a comparative perspective would also reveal contrasting national attitudes toward a crucial agent of cultural change, namely, Freudian psychoanalysis. Finally, this study will assess the results of several official commissions (particularly in England and Austria) which were established in 1920 to investigate the shell-shock crisis. Research for this project is continuing and presently focuses on the American investigation and treatment of war neuroses.

### **The Transformation of a Regional Market: Early Modern Paris and its Hinterland**

Researcher: Associate Professor Thomas Brennan

Sponsor: Naval Academy Research Council (OMN)

This is a large-scale study of the early modern French wine trade. It charts the structure and evolution of supply networks and the changing role of merchants and brokers in the national and international market through the end of the old regime. In particular, it focuses on the economic relationship developed between merchants and producers, on the use of debt and monopoly to achieve economic control. Through their use of credit and information, their control of related fields of transportation and containers, and their manage-

ment of the financial system, they attempted to dominate both ends of the market network. The researcher will investigate these processes at an individual level, using cases provided by judicial and notarial archives. The study also addresses the issue of linkages between different levels of markets and the impact of dynamic growth at the national level on the function of local producers. This project has resulted in two scholarly presentations and two articles submitted for publication.

### **Red Mike Edson**

Researcher: Major Jon Hoffman, USMC

Sponsor: Naval Academy Research Council (OMN)

This project continues the researcher's graduate school work on the life of Major General Merritt Edson, USMC. The objective is a publishable biography. The research is nearly completed.

Work has been conducted at the Library of Congress, the National Archives, and other repositories, as well as an extensive use of oral history interviews.

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### **Computer-Aided Instruction in Ethics**

Researcher: Professor David E. Johnson

Sponsor: Naval Academy Instructional Development Advisory Committee

This project is designed to develop software for use in HP232, Ethics, and the "ethics continuum" being introduced into the curriculum in History, Political Science, and Leadership and Law. The purpose of this project is to improve student mastery of some course material while increasing the classroom time available for teaching other materials. This software will be made available for midshipmen to use on their own PC's during study time. The objectives involve providing modules on (1) background information about, (2) justifications for, and (3) criticisms of specific ethical theories. A second goal of this project is to support efforts to

make more efficient use of the academic time available to midshipmen. This is achieved by the objective of intensifying instruction of midshipmen in philosophy and ethics.

The project employs a hypertext program, Linkway, developed by IBM. The investigator uses this program to design courseware modules that permit the inclusion of graphic as well as textual material.

The material to be entered into the program has been gathered and organized. The current phase involves learning the capabilities of the Linkway software and designing the modules.

### **Unwanted Immigrants: The Japanese in Latin America, 1890-1950**

Researcher: Associate Professor Daniel M. Masterson

Sponsor: Naval Academy Research Council (OMN)

This project has expanded during the past two years from a study of the Japanese presence in Latin America during the Second World War to its current status as a comprehensive survey of the Japanese diaspora in Latin America in the years before 1950. Most field research in the United States has already been completed at the National Archive., Franklin D. Roosevelt Library, Army Historical Center and Cornell University. Latin American field research has also been undertaken

in Peru and Mexico. Ms. Sayaka Funada, who has joined Professor John Bratzel and the researcher as co-authors of this study, has also completed extensive research and interviews in Sao Paulo, Brazil, regarding the Brazilian Japanese. NARC-funded research will be completed in Argentina, Paraguay, Chile, and Ecuador during the summer of 1992. A completion date of early 1995 is now anticipated for this extensive project.

### **The Illuminating Mind in Twentieth-Century American Photography**

Researcher: Associate Professor David P. Peeler

Sponsor: Naval Academy Research Council (OMN)

This project is an examination of the growth of American photography in the twentieth century. It explores the ideas and values of leading American photographers, and the ways in which they brought those beliefs and values to fruition in their work. The project fills a gap in the existing scholarship, for while there is a substantial body of art criticism on the medium, there is little substantial scholarly treatment of the ideas associated with this broad

swath of creative photography. The principal question explored is this: In what ways did these creative individuals seek to resolve the tension that arose from working in a medium with an almost worshipful attitude toward objectivity, while daily seeing the evidence in their work that even the simplest fact cannot be presented without altering its "pure" objectivity in some way?

### Hegel's Map of the Imagination

Researcher: Assistant Professor Chip Sills  
Sponsor: Naval Academy Research Council (OMN)

The purpose of this project is to develop an original theory of imagination based on a study of Hegel's *Science of Logic* understood as a systematic development of a new idea of "concept"--an idea which includes the notion of "trope." At issue is the relationship between logical and poetic modes of construing evidence. The paper, "Situations of Skepticism," presented to the Society for Systematic

Philosophy as part of the program of the Eastern Divisional meeting of the American Philosophical Association in New York City in December 1991, was developed during the period of NARC funding, and contains crucial elements of the analysis to be incorporated into the book on Hegel which will result from this project.

### Religion and Politics in the Era of Nadir Shah

Researcher: Assistant Professor Ernest Tucker  
Sponsor: Naval Academy Research Council (OMN)

This project consisted of an investigation of six contemporary sources which treat the life of Nadir Shah (1688-1747), the last pre-modern ruler of Iran. These sources were subjected to historiographical examination to explore the attitudes of contemporary chroniclers towards Nadir, long

regarded as one of the enigmas of Iranian history. The study resulted in shedding new light on contemporary views of Nadir Shah, and was completed as a Ph.D. thesis, which was defended in November 1991; the degree is to be awarded in November 1992.



## Independent Research

### **The Transformation of English Culture, 1910-1923: Tradition, Modernity, and the Great War**

Researcher: Associate Professor Theodore W. Bogacz

This book will be a synthetic study with broad implications for the cultural and social history of modern England. The researcher is examining important aspects of English culture as they underwent radical change under the impress of total war. Among other areas to be studied are: the transformation of language during World War I; the reception of new views of psychology and mental illness under the impact of the "shell-shock" crisis on the Western Front; the triumph of the modernist vision in the fine arts, as other styles failed to capture the nature of modern war; and ultimately,

the growing acceptance of the conditions of "modernity" in English culture as a whole. The years 1910-1922 in England are seen as a period of profound cultural crisis and World War I as a radically modernizing force in all areas of English life. A major focus in the writing of this book will be to chart the resistance to and acceptance of the forces of modernity in English culture in these revolutionary years. The research is completed, and a substantial portion of the manuscript has been completed.

### **Roman Use of Documentation**

Researcher: Professor Phyllis Culham

The ultimate goal of the project is a book on Roman use of documentation. Research to date has already produced four articles and five presentations. The Johns Hopkins University invited the researcher to present a seminar on her ongoing research to graduate students in its

Department of Classics. The university supplied the researcher with: the title of Visiting Professor of the Classics, use of unpublished epigraphic materials not available to the public, library resources in the form of use of the current collection and consulting the researcher's interests in expanding it, and salary.

### **Sir William Vernon Harcourt and Charles Whibley**

Researcher: Associate Professor Nancy W. Ellenberger

Charles Whibley (1859-1930) was a British journalist, literary critic, and essayist whose long career at the center of the London publishing world brought him into contact with a generation of writers--H.G. Wells, Rudyard Kipling, W.B. Yeats--who transformed English prose style in the late nineteenth century.

Sir William Harcourt (1827-1904), statesman and politician, was one of the most important figures in the Liberal Party during the second half of Victoria's reign. His long career culminated in the 1890's, when he served as Gladstone's chief lieutenant in the House of Commons and then

leader in the lower house after Gladstone's retirement. Harcourt's rivalry with Lord Rosebery for leadership of the Liberals divided the Parliamentary party throughout the decade, and contributed to their inability to provide more than a brief interlude to twenty years of Conservative party rule.

Two articles of 500 to 1,000 words written on the lives and importance of these two figures have been accepted for inclusion in Cevasco, G.A., *The Eighteen Nineties: An Encyclopedia of British Literature, Art and Culture* (Garland Publishing, forthcoming 1992).

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### **Balfour, Curzon, and Vita Sackville-West**

Researcher: Associate Professor Nancy W. Ellenberger

This project uses the character of Lord Slane in Vita Sackville-West's novel *All Passion Spent* to explore power and ambiguity in the images that aristocratic women formed of the aristocratic men

among their contemporaries who achieved great political importance. A conference paper is planned for the spring 1993 meeting of Mid-Atlantic Conference on British Studies.

### **Emergence of the Modern American Navy, 1865-1915**

Researcher: Professor Frederick S. Harrod

The project seeks an increased understanding of the process of innovation, modernization, and change within the Navy through the study of the emergence of the "new Navy" during the period 1865 to 1915.

Its purpose is to examine the many intertwined threads of change over a prolonged period. By this means it will correct simplistic views based on narrowly-based research.

### **Shield of the Republic: The United States Navy in an Era of Cold War and Violent Peace, 1945-1991**

Researcher: Associate Professor Michael T. Isenberg

This is a two-volume study of the Navy in the years indicated. Volume One covers the Cold War Navy, 1945-1962. The project is designed as an institutional history of the United States Navy, which includes operations, plans, technology, personnel, and a critique of both civilian and

military leadership. No similar work exists. The second volume will cover naval activities from the Cuban Missile Crisis through Desert Storm. Publication of Volume One is scheduled for fall 1992.

### **Elections and the Political Communities of Colonial Virginia, 1728-1775**

Researcher: Assistant Professor John G. Kolp

Elections to the eighteenth-century Virginia House of Burgesses have been of long-standing interest to historians because of the role these elections played in the early political careers of a number of America's Founding Fathers. Although these men were selected for office within their local county constituencies by a substantial proportion of the adult male population, it has never been completely clear what meaning should be attached to these political events. What did this selection process prove? Was there any real difference between gatherings or was something important being

decided at these elections? Despite considerable attention by scholars in several books and numerous articles, the precise way these elections fit into the social and political structure of colonial communities has remained obscure.

A preliminary answer to some of these important questions has been put forward in the researcher's Ph.D. thesis completed in 1988. Examination of surviving data on all elections for this period reveals a pattern of gradual decrease in electoral competitiveness over the 50-year period, but also demonstrates substantial regional variation which

does not fit traditional interpretations. Further, a number of themes emerge from detailed case studies of three counties, including the importance of tenants in the election process, the broad spectrum of issues colonial voters thought germane, the remarkable stability of voting behavior, the importance of previous officeholding to candidate

success, and the role of local neighborhoods in defining electoral choice. The manuscript is being revised and re-arranged and several chapters added.

Johns Hopkins University Press plans to publish the book manuscript as part of a new series on "The History, Context, and Culture of Early America."

### **The Dynamics of Electoral Competition in Pre-Revolutionary Virginia**

Researcher: Assistant Professor John G. Kolp

While most research on local politics in colonial Virginia has portrayed the system as static, uniform, and virtually unchanging from 1725 to 1815, this study asserts that the electoral system should be viewed as a dynamic entity responding to temporal change and to local, regional, provincial, and imperial influences. To test this assertion, every scrap of evidence on all 882 general and by-elections held between 1728 and 1775 is subjected to detailed quantitative analysis to determine the trends in electoral competition over time and the

potential differences between counties and regions of the colony.

Only about one-third of the elections held during this period are found to be competitive. Findings also suggest a general trend in electoral competition over the period under study, as well as considerable diversity between sections of the colony that do not fit previous geographical models.

This article will appear in the *William and Mary Quarterly*.

### **Discovering the Signs: Social Images of the Deaf Community in Nineteenth-Century France**

Researcher: Associate Professor Anne T. Quartararo

This research project is a synthetic study of the social and cultural forces that created the deaf community in nineteenth-century France. The researcher is focusing on the emergence of a deaf identity during a period of intense social change in western society. In the first part of the study, the revolutionary period is placed in perspective. The researcher is studying the concept of social deviance in terms of charity and public assistance. In the second part of the project, the researcher investigates the emergence of deaf community associations, initiatives for deaf education, and the

role of leading activists to improve the condition of deaf people. In the third part of the study, the researcher is looking at the uses of language and the exclusion of sign language from schools that educated the deaf in the late nineteenth century. In addition, the role of deaf-run congresses, deaf associations, and newspapers will be analyzed to understand the emergence of deaf culture. The researcher has presented a paper on the deaf activist, Henri Gaillard, which will be published in a collection of articles on deaf history in 1993.

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### **The Origins of the Modern American General Staff**

Researcher: Associate Professor William R. Roberts

Previous historians have argued that the American General Staff was patterned after the Prussian General Staff in order to make the American army a more effective fighting force. The researcher has found that the staff reforms introduced at the beginning of the twentieth century represented the culmination of a long-standing struggle for power between line and staff officers, as well as another struggle for power between the secretary of war and the nineteenth-century commanding general. Sup-

porters of the creation of the General Staff in 1903 wanted to strengthen the secretary and the line as much, if not more, than they wanted to improve the fighting skills of the army. Their reforms provided a foundation for the growing bureaucratization of the military establishment in this century.

The final product of this research is to be a monograph that already has been accepted for publication by Greenwood Press.

### **Ramus and Reform**

Researcher: Assistant Professor James V. Skalnik

This project has been the preparation of a manuscript for submission to The Johns Hopkins University Press. The book is a study of the French humanist and reformer Pierre de la Ramée (Petrus Ramus), 1515-1572, and his attempts to counteract

the increasingly hierarchical and authoritarian tendencies in French society at the dawn of the Old Regime. Funding from the National Endowment for the Humanities permitted a month of research in the National Archives in Paris.

### **The Great War, 1914-1918**

Researcher: Associate Professor Jack Sweetman

Research on all phases, fronts, and aspects of the Great War, 1914-1918, is being conducted with a very long-term view of producing a comprehensive new history of that tremendous conflict. Although single-volume surveys appear every few years, it has been more than half a century since the publication

of the most recent, multi-volume treatment in the English language. A great amount of research remains to be done before the planning and writing of the study can begin. The anticipated completion date is sometime in the early 21st Century.

### **The U.S. Marine Corps: An Illustrated History**

Researcher: Associate Professor Jack Sweetman

This work, co-authored with Lieutenant Colonel Merrill L. Bartlett, USMC (Ret.), is designed to provide a concise but authoritative history of the U.S. Marine Corps from the foundation of the Continental Marines in November 1775 to the present. The narrative is to follow a chronological format. This researcher will contribute the chapters up to American intervention in World War One; Colonel Bartlett will contribute the remainder. The division was dedicated on the assumption that the

personal experience which Colonel Bartlett--twice winner of the Marine Corps Historical Foundation's prestigious, annual Heinl Award for the best article on Marine Corps history--brings to the project will become progressively more valuable as the coverage nears the present. The project length is approximately 65,000 words. The work will include numerous, carefully-chosen illustrations and maps, as well as several appendices. It is anticipated that the project will be completed by early 1993.

### **The Great Admirals: Centuries of Command at Sea**

Researcher: Associate Professor Jack Sweetman

The object of this work is to survey the careers and, most importantly, to examine the leadership style and skills of nineteen admirals--six British, four American, two Dutch, two Japanese, and one each Austrian, Danish, French, German, and Greek--who commanded in fleet engagements from the Elizabethan Age to the close of World War Two. Original essays have been prepared by a distin-

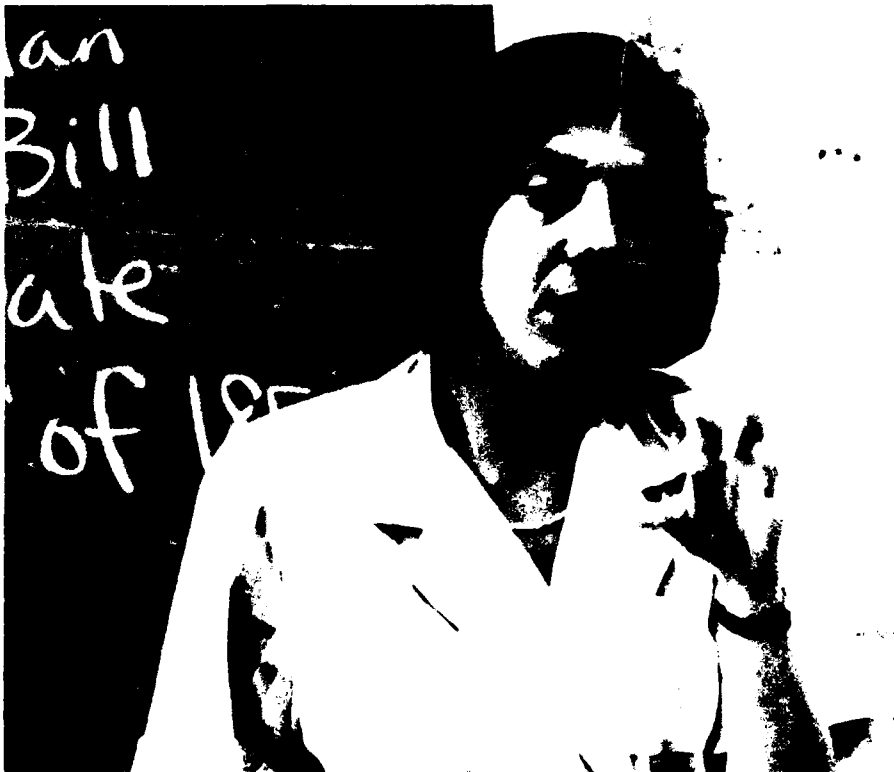
guished, international team of academic, official, and private historians and naval officers from Australia, Austria, Canada, Denmark, France, Greece, The Netherlands, the United Kingdom, and the United States. The work will be approximately 125,000 words in length. The projected completion date is fall 1992.

### **A Topical History of the Third Reich**

Researcher: Professor Larry V. Thompson

Research is being conducted for a book-length synthesis of National Socialist Germany. Topically organized, the study is both interpretive and derivative. It seeks to demonstrate the experience of everyday life under National Socialism while documenting the extent of polycratic rather than dictatorial rule exhibited by the regime. Based

upon extensive archival research and current scholarship over the past quarter century, the book, when completed, will contribute to the continuing scholarly debate on whether or not the Nazis were functionalists or intentionalists in program and practice.





## **Research Course Projects**

### **The Costs of Revisionist Optimism: Nationalists, Racists, and Fascists in Trianon, Hungary**

Researcher: Midshipman 1/C Joseph K. Ford, USN  
Adviser: Professor Larry V. Thompson

This study is an analysis of how Fascism dominated Hungarian politics during the interwar years and throughout World War II. Prewar Hungarian-German relations were cordial, and both nations cultivated close economic ties. Moreover, both states were revisionist in pursuing the dismantling of provisions of the World War I peace settlement which had reduced their territorial size. Finally,

Hungary and Germany shared a commitment to anti-Semitism as an integral part of their proposed solution to their respective internal and international problems. The prewar politics of Trianon, Hungary, thus established the foundation for the World War II alliance with Germany which became an integral component of Hitler's Eastern strategy after June 1941.

### **The Red and the Grey: The Choctaw Nation's Decision to Join the Confederacy**

Researcher: Midshipman 1/C Donald E. Kennedy, USN  
Adviser: Associate Professor Mary A. DeCredico

This project represented the culmination of over a year of research. It was completed under the auspices of the History Department's Honor Program. Research, including material from the Mississippi Department of Archives and History, and the National Archives, demonstrated that the Choctaw decision to join the Confederacy was based upon the tribe's perception of thirty years of broken

promises from Washington. The researcher refuted the commonly-held belief that slavery formed the only tie that bound the Choctaws to the South. Further, he argued that the Choctaw saw that an alliance with white Southerners might not produce a change in material conditions for the tribe, but that the Confederacy's promises did hold out that possibility.

### **Reconstruction Democracy: The Politics of Responsibility**

Researcher: Midshipman 1/C Ernest D. Miller, Jr., USN  
Adviser: Associate Professor David P. Peeler

Pragmatism is the most "purely American" of Western intellectual movements. It developed among a small group of prominent American thinkers during the late nineteenth century, and then flourished in the United States before becoming a major factor in the larger Western intellectual landscape of the twentieth century. This project traces the ideas of three American pragmatists: Charles Saunders Peirce (1839-1914), William James (1842-1910), and John Dewey (1859-1952). Peirce attacked earlier dichotomies between empiricism and rationalism, James applied that work to the problem of human knowledge, and

Dewey then translated their conclusions into a political doctrine that humans have not just the opportunity to rule their lives but also the responsibility of doing so. The researcher demonstrates that one of the main threads connecting these three men's ideas was a very modern one--that ideas and truths are better thought of as contingencies rather than as absolute certainties. Finally, the researcher shows that for all their willingness to view the world as a place of ambiguity, these pragmatists remained optimistic about the human condition in general, and in particular about democracy's political future.

### **The Second British Invasion of Afghanistan: Controlling Information and Creating Imagery in an Imperial War**

Researcher: Midshipman 1/C John B. Moulton, USN  
Adviser: Associate Professor Nancy W. Ellenberger

In 1878, the British government in India, attempting to forestall Russian influence, launched an invasion of the independent mountain kingdom of Afghanistan. After initial successes, the effort met with a disaster that evoked a similar tragedy of forty years before: in September 1879, the British resident in Kabul was massacred along with all his forces. The set-back was particularly embarrassing for the Conservative government of Benjamin Disraeli, which had just seen its military suffer a resounding defeat at the hands of Zulu warriors in South Africa. Fortunately for the government, however, the British Parliament was in recess. Opposition politicians were away from London and their usual sources of information. The opportunity to downplay the incident until British authority had been re-established in Kabul presented itself to the

Conservatives.

This paper examines attempts by the British officials responsible for the 1878 invasion of Afghanistan to control information about the unfortunate reversal of their policy and the responses of the press and liberal critics back home to this effort. It traces the methods by which information passed from the mountainous front, through the bureaucracies in India and Whitehall, and on to the press and the public in London. It argues that the Conservatives, while ineffectively trying to control information from the front, failed to provide the public with any compelling image of this distant war. Their neglect allowed the Liberals under W. E. Gladstone to create the imagery of the campaign to their own advantage, and contributed to the Conservatives' defeat in the election of 1880.

### **Landed Wealth and Power in the Anglo-Norman Settlement**

Researcher: Midshipman 1/C R. Chad Muse, USN  
Adviser: Associate Professor Richard P. Abels

During the twenty years following the Norman invasion of England in 1066, the English nobility was swept away from their lands and replaced by a new Anglo-Norman aristocracy. By the time of the Domesday Book inquiry (1086) less than ten per cent of lands in England remained in English hands. Although historians have often examined the changes that occurred in the English tenurial structure immediately following the Conquest, few have investigated the specific ways in which the new Anglo-Norman aristocracy made use of its lands, both economically and politically. The implicit assumption has been that the Anglo-Norman barons formed a homogenous class in terms of their economic interests and land management policies.

The purpose of this research project was to investigate the different ways in which members of the Anglo-Norman aristocracy used its land. Using a computer-assisted statistical analysis of the data

supplied by William the Conqueror's massive inquest into English landholding and economic resources, Domesday Book, the researcher compared the different land practices of three of King William's most important tenants-in-chief, and analyzed the economic and political effects of their particular policies of land management.

Domesday Book evidence suggests that military men considered land as a means to prepare for wars, creating wealth, and geographical leverage to build alliances. To the administrator type landholder his holding served as a political tool--specifically to amass political supporters. The economic uses showed that magnates managed their lands more profitably than locals, but no evidence showed why. It was concluded from this study that Anglo-Norman aristocracy was not a homogenous class with regards to land management.

### George Washington's Relations with the Continental Congress

Researcher: Midshipman 1/C George B. Rowell IV, USN  
Adviser: Professor John W. Huston

Although George Washington has been studied exhaustively as a military officer and President of the United States, little attention has been paid to his role with the civilian leadership of the nation during the struggle for independence. This study, relying heavily upon primary source materials, including Washington's writings and diaries, as well as the papers and correspondence of the members of the Continental Congress, traces his relations with the Congress from his appointment as Commander-in-Chief through the end of the Second Continental Congress, April 1781. The study concentrated on such issues as personnel, logistics, and strategy, with emphasis on the precedents being established for civilian control over the military which, in the case of the United States, emerge

from this period. In addition, the study examined Washington's dilemmas, as he had to deal not only with the Continental Congress but also with the states, as the bulk of their militias looked to their own state legislatures rather than to the Continental Congress for support and direction.

Among other conclusions the study emphasized Washington's characteristics of extreme patience, recognition of the supremacy of the civilian over the military, flexibility, and the ability to improvise.

At the regional meeting of Phi Alpha Theta, History honorary fraternity, a condensed version of this paper won second place in the competition, representing papers submitted from this entire region.



# Publications

ABELS, Richard P., Associate Professor, "Introduction to Hertfordshire Domesday," in *Hertfordshire: The Domesday Book Facsimile*. London: Alecto Historical Editions, 1991, pp. 1-36.

ABELS, Richard P., Associate Professor, "Introduction to Bedfordshire Domesday," in *Bedfordshire: The Domesday Book Facsimile*. London: Alecto Historical Editions, 1991, pp. 1-52.

The introductions are comprehensive discussions of the histories of these two counties in the early middle ages and of the Domesday Book inquests conducted in them in 1086. King William the Conqueror's great survey of landholding in his realm remains based on economics and political conditions in eleventh-century England. The introductions analyze the various types of information provided in the county inquests, examining what they reveal about geography, population, tax assessments, economic resources, and tenurial arrangements in eleventh-century Hertfordshire and Bedfordshire. The emphasis in each introduction is on the tenurial histories of the counties. Particular attention is paid to the role of lordship in shaping the tenurial landscapes of Bedfordshire and Hertfordshire, and to the mechanisms by which the Anglo-Saxon landholding elite was displaced by their Norman, Breton, and French successors.

ARTIGIANI, P. Robert, Professor, "Social Evolution: A Nonequilibrium Systems Model," E. Laszlo, Ed., *The New Evolutionary Paradigm*. New York: Gordon and Breach, 1991, pp. 93-130.

A conceptual model based on interdisciplinary research is developed showing how social systems can self-organize by correlating the behaviors of their human components under the influence of various thermodynamic and information flows.

ARTIGIANI, P. Robert, Professor, "Social Change: Insights and Implications From Contemporary Science," F. Geyer, Ed., *The Cybernetics of Complex Systems*. Los Angeles: Duwe, 1992, pp. 187-198.

Societies are treated as complex, far-from-equilibrium systems that are vulnerable to perturbations and fluctuations whose consequences are, in principle, unpredictable. Consequently, traditional top-down command and control models are not likely to be effective management guides. Admiral Horatio Nelson is used as an example of

how to organize social systems embedded in ambiguous environments, so that they are capable of evolving efficiently.

BOGACZ, Theodore, Associate Professor, Essay-length review of four books on World War I, *Journal of Modern History*, 63,3 (September 1991), 559-564.

Four recent secondary works are assessed here in an effort to discover current scholarly trends in the study of the Great War. What is evident immediately is that today the approach of the military historian is no longer considered sufficient to comprehend the complex nature of the First World War. Thus the writers under review have moved away from traditional military historical narrative and have embraced diverse methodologies ranging from precise statistically-based social history (for example, of the impact of total war on the diet of civilians) to impressionistic analysis of changing cultural attitudes (such as a new receptivity to violence in Germany as a result of the war). The reviewer concludes that what is needed to understand this war in all its complexity is a final heroic scholarly synthesis which utilizes a range of methodologies, including military, social, and cultural history.

COGAR, William B., Associate Professor, *Dictionary of American Admirals of the U.S. Navy*, Vol. II, 1901-1918. Annapolis: Naval Institute Press, 1991.

This reference book aimed at providing biographical data about the U.S. Navy's leadership during the era of Mahan and T.R. Roosevelt, continues a series which began with a biographical review of the U.S. Navy's first admirals from Admiral Farragut to era of the Spanish American war in Volume I.

CULHAM, Phyllis, Professor, "Documents and Domus in Republican Rome," *Libraries and Culture*, 26 (1991), 119-134.

Foucauldian theories of resemblance and similitude are useful for analyzing Roman diplomatic documents which survive in Greek translations. Such a study demonstrates that Roman diplomatic documents were not designed to allow a researcher to recover an "original" or "Master" text. Where they do refer to the locations of other documents, it is for the purpose of bolstering their own authority.

CULHAM, Phyllis, Professor, "Defense in Depth: Strategy, System, and Self-Similarity," *Time, Rhythms and Chaos*. Ames: Iowa State University Press, 1990, pp. 161-176.

Late Roman Defense in Depth is a self-constructing, fractal system exhibiting striking similarity of scale. Its redundancy provided great regenerative capacity. What E. Luttwak has called paradox in combat can be explained by the use of fractal analysis. Luttwak was correct in his general conclusion that the Roman model is useful to those designing American strategies of employment.

CULHAM, Phyllis, Professor, "Decentering the Text: The Case of Ovid," *Helios*, 17 (1990), 161-170.

"Feminist efforts to generate 'new readings'" of canonical authors are largely a waste of time and energy. Such efforts only reinforce the canon itself and do not enable instructor or students to get a critical distance on the canon. Historical studies integrating all relevant evidence are superior to the one-author attempt at revisionism.

CULHAM, Phyllis, Professor, "Authenticity not Authority for Feminists: A Modest Existentialist Proposal," *Newsletter on Feminism and Philosophy*, 89 (1990), 75-79.

The study of aesthetics has traditionally tried to formulate criteria for judging a work absolutely without regard to individual reactions to it. Such formalism is inappropriate in feminist aesthetics. It is possible to marshall indignation or other "emotional" responses to various sorts of art without succumbing to unscholarly subjectivism.

GOOD, Jane, Associate Professor, co-author, *Babushka: The Life of the Russian Revolutionary E.K. Bresko-Breshkovskaia*. Boston: Oriental Research Partners, 1991.

Set against the backdrop of revolutionary Russia, this book chronicles the transformation of Breshkovskaia from pampered daughter of the nobility to "Babushka," hailed around the world as the "Little Grandmother" of the Russian revolution. At age thirty Breshkovskaia left her husband and gave up her infant son to join a populist commune in Kiev. Arrested for her participation in the "to the people" crusade in 1874, she endured two decades of Siberian exile. Upon release in 1896 she plunged back into revolutionary activity as a founding member of the Socialist Revolutionary Party. In 1904 she made a lengthy speaking tour of America, where she was embraced by American progressives as the symbol of opposition to tsarist brutality. Another decade of Siberian exile was ended when Alexander Kerensky brought her to

Petrograd as his confidant during the last months of the 1917 Provisional Government, but the Bolshevik Revolution sent her into foreign exile, where she ended her life in 1934 as an anti-communist crusader living in Czechoslovakia. Although the details of her life are unique, Babushka was in many respects typical of the women of the intelligentsia. In broad brush, her journey through life represents the collective experience of all female Russian revolutionaries who sacrificed their personal comfort for what they considered a noble cause.

HOFFMAN, Jon, Major, USMC, "Edson's First Raiders," *Naval History*, (Fall 1991).

This article recounts the story of Captain Merritt Edson and his operations in the Coco River area of Nicaragua in 1928-1929. He and a small unit of Marines executed a series of patrols that played a large part in the anti-Sandinista counterinsurgency campaign of that period. The tactics and procedures developed by Edson were later used by him to update the USMC's Small Wars Manual, the first published United States counterinsurgency doctrine. As a result of his expertise in the area, Edson was selected to create, organize, and lead the first Raider Battalion in World War II. The article is based on extensive research in primary documents and is a brief summary of the author's master's thesis on the same subject.

HOFFMAN, Jon, Major, USMC, "Back to the Future," *Marine Corps Gazette*, (December 1991).

This article follows up an earlier one on the same subject titled "The Future of Forcible Entry." It continues a discussion on the feasibility of making amphibious assaults against defended shores in the future. The author looks in particular at the role to be played in such operations by the proposed Advanced Amphibious Assault Vehicle, a follow-on to the current AAV-7 armored assault vehicle in use by the U.S. Marine Corps. The piece argues that the capabilities of the vehicle will be military power, and that it will be insufficiently capable for high end threats without the addition of several other expensive capabilities not presently available in sufficient quantity or quality (e.g. naval gunfire, mine clearance, etc.).

LOVE, Robert W., Jr., Associate Professor, *History of the U.S. Navy, 1775-1941*, Volume I. Harrisburg: Stackpole Press, 1992.

This book argues that American naval policy, operations, and strategy can best be understood by examining the Navy as the handmaiden of U.S. foreign policy. The architecture of the entire study consists of two volumes and divides the subject into three great periods.

From the Revolutionary War to the defeat of Spain in 1898, Navy men and the politicians they served used the fleet to achieve independence, to acquire defensible coastal, mountain and river frontiers, to advance continentalism, to resolve competing versions of American nationalism, and to defense overseas maritime access to Asia, Africa, and Latin America.

From the turn of the century until World War II, the United States acted as the arbiter of global world power. During these years the Navy was more than ever the mailed fist of American diplomacy. Volume I brings the story up to the very eve of the attack on Pearl Harbor and the Navy's entry into the decisive struggle that prefaced the Cold War.

MASTERSON, Daniel M., Associate Professor, *Militarism and Politics in Latin America: Peru from Sanchez Cerro to Sendero Luminoso*. Westport: Greenwood Press, 1991.

This book is a comprehensive case study of the modern Peruvian armed forces. It examines the professional development of South America's most controversial military establishment from the early 1930's to the present. Based upon extensive research in Peruvian and U.S. archives and numerous interviews with active and retired members of the Peruvian armed forces, this study is placed in the context of Peruvian national politics and South American military affairs. Particular emphasis is given to the impact of French and U.S. military theory upon the Peruvian military mentality. Revolutionary politics from the APRA party in the 1930's to today's *Sendero Luminoso* also figures prominently. This study also explores the rationale behind the sweeping social and economic reforms of the military government of General Juan Valesco Alvarado (1968-1975) and assesses the Velasco government's legacy for contemporary Peru. For the first time the Soviet Union's heavy involvement in Peru since the early 1970's is examined. As the only comprehensive study in English of the modern Peruvian military, this book will add to the limited literature on the historical evolution of Peru's military in Spanish. The author plans a Spanish translation of this book to be published in Peru or Argentina.

NELSON, Samuel H., Assistant Professor, "Africa Responds to AIDS: The Challenges and Strategies of Disease Prevention," *Journal of Third World Studies*, 8, 2(Fall 1991) 97-126.

Although all regions of the world currently report cases of AIDS, the World Health Organization estimates that the magnitude and long-term impact of HIV infection will be greatest in Africa. In the absence of a vaccine, the current fight against AIDS

has centered on two major strategies to limit further infection: careful blood screening and a comprehensive educational program designed to modify sexual behavior. The socio-economic situation in Africa, however, poses some unique obstacles to these efforts to combat AIDS. Insufficient funding, the continuing denial of personal risk, the stigmatization of AIDS victims, and wide-spread poverty are among the most serious challenges to effective disease prevention in Africa.

PEELER, David P., Associate Professor, "Power, Autonomy and Weston's Imagery: A Balancing Act," *History of Photography*, 15 (Autumn 1991), 194-202.

Edward Weston (1886-1958) was a photographer, not a philosopher. But Weston had his metaphysical moments. He believed that reality had two distinct dimensions: one that was merely physical and perceived by the senses, and a higher, transcendental one that the mind alone understood. As a photographer, Weston hoped to partake of both dimensions, but he also believed that he must balance carefully between them. His dedication to the natural world drew him towards the copy, and his respect for originality drew him toward the transcendental. No matter how much his biases disposed him towards the purely mental, he could not photograph without some lowly physical object before him; and no matter how much he loved the objects that he photographed, he was not content to be a mere sensualist. Consequently, Weston undertook years of anguished balancing, constantly watchful lest his work fall to one extreme or the other. Unable to empower the mind without dominating the object, Weston was likewise unable to celebrate the object without deprecating the mind.

ROBERTS, William R, Associate Professor, and Jack SWEETMAN, Associate Professor, Eds., *New Interpretations in Naval History: Selected Papers from the Ninth Naval History Symposium, 18-20 October 1989*. Annapolis: Naval Institute Press, 1991.

The twenty-three papers in this published volume were originally presented at the Ninth Naval History Symposium held at the Naval Academy in October 1989. It is the director's task to select and edit the papers to be included in the publication. In addition to editing all of the papers, a camera-ready copy of the final edited version of each essay was prepared in order to eliminate the need for typesetting and to speed the time required for printing by the Naval Institute Press.

The essays included in this book cover a wide variety of topics and times, ranging from the Athenian Navy in the Fifth century B.C. to the origins of the commitment of the United States

Navy in the Persian Gulf. The authors include well-known scholars and official government historians from the United States and six foreign countries. Their essays were grouped into seven categories or sections in the book and published with illustrations in time for the succeeding Tenth Naval History Symposium held in September 1991.

SILLS, Chip, Assistant Professor, *Philosophy of Discourse: The Rhetorical Turn in Twentieth-Century Thought*, two volumes, co-editor with George Jensen. Portsmouth, New Hampshire: Heinemann, 1992.

*Philosophy of Discourse* provides an initial orientation for an understanding of the complex developments of twentieth-century critical theory. An introductory essay by Chip Sills sets the context of the "Rhetorical turn" as a generalized movement away from the dominance of positivist modes of thought. A number of prominent figures in twentieth-century philosophy and social theory are given a didactic and critical introduction. Volume One comprises chapters on philosophy of science, C.S. Peirce, Richard Rorty, Theodor Adorno, Jurgen Habermas, Mikhail Bakhtin, Kenneth Burke, Walter Ong, and Hayden White. Volume Two has chapters on Claude Levi-Strauss, Jacques Lacan, Jacques Derrida, Michel Foucault, Jean-Francois Lyotard, Martin Heidegger, Hans-Georg Gadamer, Ernst Cassirer, and feminist theory.

SWEETMAN, Jack, Associate Professor, Series Editor, "Classics of Naval Literature."

This Naval Institute Press series is designed to provide useful new editions of classic works of naval history, biography, and fiction. In addition to the unabridged, original text, each work includes a substantial introduction and, when appropriate, notes by an authority in the field. The following works appeared during this reporting period:

Sakai, Saburo, with Martin Caiden and Fred Saito. *Samurai!* Introduction by Barrett Tillman. Annapolis: Naval Institute Press, 1991.

Fuchida, Mitsuo and Masatake Okumiya, ed. Clarke H. Kawakami and Roger Pineau. *Midway, The Battle That Doomed Japan: The Japanese Navy's Story*. Introduction by Thomas B. Buell. Annapolis: Naval Institute Press, 1992.

SWEETMAN, Jack, Associate Professor, "The Influence of Napoleonic Tactics on the American Civil War, 1861-1865," *The Influence of the French Revolution in the Armies in France, in Europe and in the World: Proceedings of the Fifteenth International Colloquium on Military History*. Vincennes: Commission Francaise d'Histoire Militaire, 1991, II: 297-309.

From its inception until the outbreak of the Civil War, the United States Military Academy on West Point based its instruction in the art of war on an analysis of the campaigns of Napoleon and its drills and exercises on those of his armies. During the Civil War, academy graduates dominated the senior ranks of the Union and Confederate armies alike. Of the sixty largest battles fought, West Pointers commanded both sides in fifty-five and one side in the others. This paper examines the influence of their professional education, combined with their experience as junior officers in the Mexican War and post-graduate reading, on their conduct in high command. It concludes that the extraordinarily high casualty rates typical of Civil War battles resulted in large part from their application of tactical models that technological improvements in small arms in the 1850's had rendered obsolete.

SWEETMAN, Jack, Associate Professor, "To Cut a Sleeping Throat," U.S. Naval Institute *Proceedings*, 12 (December 1991), 30-31.

Published on the 50th anniversary of the U.S. entry into World War II, this article reviews the Japanese attack on Pearl Harbor and American reactions to that event. Dismissing the theories sometimes advanced that the Pacific fleet was the victim of a presidential conspiracy of silence, it ascribes U.S. unreadiness to simple human error. The title is taken from a remark supposedly made by Admiral Isoroku Yamamoto, Commander-in-Chief of the Japanese Combined Fleet, upon learning that the attack had preceded the delivery of the Japanese war message: "It does not do to cut a sleeping throat."

SWEETMAN, Jack, Associate Professor, "Sacrifices Must be Made," U.S. Naval Institute *Proceedings*, 2 (February 1992), 14-15.

In January 1942 the ABDA (American, British, Dutch, Australian) command was established in an unsuccessful attempt to halt the Japanese offensive at the so-called Malay Barrier extending from Singapore through the Netherlands East Indies to New Guinea. This article describes the destruction of the ABDA float Striking Force under the tactical command of Rear Admiral Karel W.F. Doorman, Royal Netherlands Navy, at the Battle of the Java Sea a month later.

SWEETMAN, Jack, Associate Professor, "Bombers from Shangri-La," U.S. Naval Institute *Proceedings*, 4 (April 1992), 38-39.

In April 1942 sixteen U.S. Army Air forces twin-engine B-25 Mitchell bombers launched from the carrier *Hornet* attacked Tokyo and other Japanese cities. This daring exploit, known after its Navy and

Air Force commanders as the Halsey-Doolittle Raid, boosted American morale and exerted a baneful influence on the unfolding of Japanese strategy. Asked by newsmen where the bombers had begun their flight, President Franklin D. Roosevelt replied that they had come from Shangri-La.

SWEETMAN, Jack, Associate Professor, "Coral Sea," U.S. Naval Institute *Proceedings*, 5 (May 1992), 36-37.

The first carrier air battle in history was fought between Japanese and American forces off New Guinea on 7-8 May 1942. Although in terms of enemy tonnage sunk the outcome appeared to favor the Imperial Navy, in reality it had suffered both a tactical and strategic defeat, losing the services of two fleet carriers for the upcoming Central Pacific offensive and aborting the projected assault on Port Moresby. This article surveys the background and course of the engagement and seeks to assess its impact on subsequent developments.

SWEETMAN, Jack, Associate Professor, "The Battle of the Coral Sea," *Officer Review*, 8 (May 1992), 14-16.

The preceding article examined the Battle of the Coral Sea primarily from a strategic standpoint, with particular reference to the conflict that developed in the Japanese decision-making process between the Naval General Staff and Admiral Isoroku Yamamoto, Commander-in-Chief of the Combined Fleet. The present article, while touching on Japanese planning, approaches the subject mainly from the American perspective and is more operational in its orientation. It also reproduces part of the citation accompanying the Medal of Honor that Lieutenant Joseph J. Powers (USNA 1935), a dive-bomber pilot, was posthumously awarded for extraordinary heroism during the attacks on the carriers *Shoho* and *Shokaku*.

SWEETMAN, Jack, Associate Professor, "Midway," U.S. Naval Institute *Proceedings*, 6 (June 1992), 74-75.

On 4-6 June 1942 the U.S. Pacific fleet inflicted a stunning defeat on the Japanese Combined Fleet at the Battle of Midway, destroying the carriers *Akagi*, *Hiryu*, *Kaga*, and *Soryu* while losing only the *Yorktown*. The outcome of the action was all the more remarkable in that in the overall number of surface combatants deployed in the Central and Northwest Pacific the Imperial Navy enjoyed the apparently overwhelming superiority of 2.4:1. The principal ingredients of the upset victory achieved by U.S. forces are analyzed in this article, which also

sets the Midway campaign in the strategic context of the Pacific War.

SWEETMAN, Jack, Associate Professor, "The Battle of Midway," *Officer Review*, 9 (June 1992), 10-11.

Poor planning, poor decisions, and bad luck on the part of the Japanese Combined Fleet and good planning, good decisions, and good luck on the part of the U.S. Pacific fleet combined to put Vice Admiral Chuichi Nagumo's First Carrier Striking force at a serious disadvantage at the opening of the Battle of Midway. In the final analysis, however, the outcome depended on the performance of the aviators from the USS *Enterprise*, *Hornet*, and *Yorktown*. This article centers on the attacks delivered by the U.S. torpedo-bomber squadrons, which, though unsuccessful in themselves, left the Japanese carriers vulnerable to the dive-bombers that appeared immediately afterwards.

SWEETMAN, Jack, Associate Professor, and William R. ROBERTS, Associate Professor, Eds., *New Interpretations in Naval History: Selected Papers from the Ninth Naval History Symposium*. Annapolis: Naval Institute Press, 1991.

The Ninth Naval History Symposium, attended by more than 200 registrants from the United States and 11 foreign countries, was held at the U.S. Naval Academy, 18-20 October 1989. This volume contains edited versions of 21 of the 55 papers that were presented. Their topics range across the spectrum of international naval history from "The Rhodian Navy in the Hellenistic Age" to "The Mutiny of HNLMS *De Zeven Provinciën*: Unions and Recruitment in the Royal Netherlands Navy, 1890-1950" and "A Feather in their CAP? The Marines' Combined Action Program in Vietnam."

SYMONDS, Craig L., Professor, *Joseph E. Johnston: A Civil War Biography*. New York: W.W. Norton & Co., 1992.

This book is a full-length biography of Confederate General Joseph E. Johnston. Johnston was the highest-ranking U.S. Army officer to resign his commission and "go south" to offer his services to the Confederacy. He commanded Confederate armies at the Battle of Bull Run (Manassas) and Seven Pines (Fair Oaks), where he was wounded and succeeded by his West Point classmate Robert E. Lee. After his recuperation, he assumed supreme command of Confederate armies in the western theater and was closely associated with the unsuccessful defense of Vicksburg in the summer of 1863. After a series of disagreements with Confederate President Jefferson Davis, he was demoted to a small regional command. In



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December 1863, Johnston was restored to the command of one of the Confederacy's two major field armies--the Army of Tennessee. His campaign against Union Major General William T. Sherman in Georgia is very controversial among historians. While many praise Johnston for conserving his army, others attack him for failing to repel Sherman. In July 1864 President Davis relieved Johnston in a very controversial move and replaced him with John Bell Hood. Johnston returned to command for a third time in the twilight of the Confederacy, fighting its last battle at Bentonville in March 1865. After the war he served as a congressman from Virginia and--in his eighties--as U.S. Railroad Commissioner. He died in 1891 after catching pneumonia at Sherman's funeral.

SYMONDS, Craig L., Professor, Gettysburg: A Battlefield Atlas. Baltimore: Nautical & Aviation Press, 1992.

This volume illuminates the strategic and tactical movements of the armies of both sides in the Civil War Battle of Gettysburg, 1-3 July 1863. The book includes twenty-four full-page, three-color maps depicting all the important movements from the beginning of the campaign along the Rappahannock, to Lee's retreat back across the Potomac. The text is keyed to the maps and includes five essays about

the principal commanders and the crucial decisions. It includes a suggested battlefield tour, and an appendix offers a detailed order of battle and casualty figures.

SYMONDS, Craig L., Professor, *A Year on a Monitor and the Destruction of Fort Sumter* (paperback edition). Columbia: University of South Carolina Press, 1992.

This is a paperback edition of the 1987 hardback volume recounting the short naval career of ship's boy Alvah Hunter, who served on the monitor *Nahant* during the siege of Charleston and the bombardment of Battery Wagner and Fort Sumter. Based on his journal, it offers a fresh look at both the siege itself, and more important, a view of shipboard life on an ironclad monitor of the Civil War era.

TUCKER, Ernest, Assistant Professor, translation of Sadig Hidayat, "Abji Khanam," in H. Moayyad, ed., *Stories from Iran: A Chicago Anthology, 1921-1991*. Washington: Mage Publishers, 1992, pp. 49-58.

This project is a translation of a short story by one of the most important modern Iranian short story writers.



## Presentations

ABELS, Richard P., Professor, "Paying the Dane-geld: The Military Policies of Alfred the Great and Aethelred the Unready," International Conference of the Haskins Society for Anglo-Saxon, Anglo-Norman, Angevin, and Viking History, Houston, Texas, 8 November 1991.

ABELS, Richard P., Professor, "Alfred the Great's Conception of Kingship," International Congress of Medieval Studies, Kalamazoo, Michigan, 9 May 1992.

APPLEBY, David F., Assistant Professor, "Miracles and the Modern Mind: Einhard's *Translation of Saints Marcellinus and Peter in Modern Historiography*," Midwest Medieval History Conference, Thirtieth Annual Meeting, Saint John's University, Collegeville, Minnesota, 19 October 1991.

ARTIGIANI, P. Robert, Professor, "Chaos and the Constitution," Central European University, Prague, Czechoslovakia, 9 September 1991.

ARTIGIANI, P. Robert, Professor, "Systems and Meaning," American Semiotic Society, University of Maryland, College Park, Maryland, 27 October 1991.

ARTIGIANI, P. Robert, Professor, "From Copenhagen to Brussels--A Literary Journey," Science and Literature Society, Montreal, Canada, 12 October 1991.

CULHAM, Phyllis, Professor, "A Decade of Studies of Roman Imperialism," Annual Meeting of the American Philological Association, Chicago, Illinois, 28 December 1991.

COGAR, William B., Associate Professor, "The American Political System," Kingsbridge Upper School, Kingsbridge, Devon, United Kingdom, 15 November 1991.

HAGAN, Kenneth J., Professor, "History of the U.S. Navy," Marine Corps Command and Staff College, Quantico, Virginia, 16 August 1991.

HAGAN, Kenneth J., Professor, "History of U.S. Naval Power," Thirtieth Anniversary of Swedish Armed Forces Staff and War College, Stockholm, Sweden, 9-10 October 1991.

HAGAN, Kenneth J., Professor, "History of the United States Navy, 1775-1991," Canadian Forces Command and Staff College, Toronto, Canada, 20 and 30 October 1991.

HAGAN, Kenneth J., Professor, "U.S. Naval History," American Naval History Seminar, National War College, Fort McNair, Washington, DC, 7 November 1991.

HAGAN, Kenneth J., Professor, Panel Chair, "The Constitution and American Diplomacy: Historical Perspectives and Critical Assessments," American Historical Association Annual Meeting, Chicago, Illinois, 29 December 1991.

HAGAN, Kenneth J., Professor, "Making of American Seapower," NROTC Unit, George Washington University, Washington, DC, 19 February 1992.

HAGAN, Kenneth J., Professor, Panel Commentator, "Carrier Operations in World War II: The Pacific," Fifty-ninth Annual Meeting of the Society for Military History, Fredericksburg, Virginia, 10-12 April 1992.

HAGAN, Kenneth J., Professor, "American Submarine Strategy in the Pacific in World War II" and "Pearl Harbor: A Nelsonian Battle and an American Victory," Third Annual Spring Conference, Eisenhower Center for Leadership Studies, University of New Orleans, Louisiana, 12-13 April 1991.

HOFFMAN, Jon, Major, USMC, "Counter-insurgency Along the Coco," Society for Military History Meeting, Quantico, Virginia, 11 April 1992.

HUSTON, John W., Professor, "George Washington as Seen by Maryland," History Honors, Western Maryland College, Westminster, Maryland, 31 March 1992.

HUSTON, John W., Professor, "The Presidents of the United States and Annapolis," St. John's College Lecture Series, Annapolis, Maryland, 21 February 1992.

JOHNSON, David E., Professor, "Conceptual Obstacles to Peace," World Conference of Philosophy, Nairobi, Kenya, 10 July 1991.

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JOHNSON, David E., Professor, "Militarism and Regional Conflicts," Concerned Philosophers for Peace Conference, Knoxville, Tennessee, 20 October 1991.

JOHNSON, David E., Professor, "Philosophical Ethics," Colloquium of the Leadership and Law Department, U.S. Naval Academy, Annapolis, Maryland, 11 December 1991.

KOLP, John G., Assistant Professor, "Electoral Politics on the Virginia Southside: Halifax County, 1752-1775," Colloquium at the Institute for Early American History and Culture, Williamsburg, Virginia, 19 November 1991.

LOVE, Robert W., Jr., Associate Professor, "Franklin Roosevelt as Commander-in-Chief," Conference on "The United States and Japan in World War II," Hofstra University, New York, 5 December 1991.

LOVE, Robert W., Jr., Associate Professor, "The U.S. Navy and Pearl Harbor," Conference on "The United States and Japan in World War II," Hofstra University, Hempstead, Long Island, New York, 7 December 1991.

LOVE, Robert W., Jr., Associate Professor, "Operation Roll of Drums and Admiral Ernest J. King," Annual Meeting of the American Military Institute, Fredericksburg, Virginia, 13 April 1992.

LOVE, Robert W., Jr., "The U.S. Navy and the Battle of the Atlantic," Annual Meeting of the North American Oceanic History Society, Washington, DC, 23-25 April 1992.

MASTERSON, Daniel M., Associate Professor, "The Peruvian Armed Forces as Civilizers," Cornell University Latin American Studies Center, Ithaca, New York, 5 August 1991.

MASTERSON, Daniel M., Associate Professor, "Unknown Internees: The Latin American Japanese, 1940-1945," Association of Third World Studies Conference, Philadelphia, Pennsylvania, 14 October 1991.

MASTERSON, Daniel M., Associate Professor, "Peru's Shining Path: Maoism or Madness,"

Industrial College of the Armed Forces, Washington, DC, 23 November 1991.

MASTERSON, Daniel M., Associate Professor, "U.S.-Latin American Relations in the Post-Cold War Era," Georgia Southwestern College, Americus, Georgia, 23 January 1992.

MASTERSON, Daniel M., Associate Professor, "Latin American Subversive Movements," Inter-American Defense College, Washington, DC, 25 February 1992.

MASTERSON, Daniel M., Associate Professor, "The Latin American Field Research Data Bank," Mid-Atlantic Council of Latin American Studies, College Park, Maryland, 4 April 1992.

MASTERSON, Daniel M., Associate Professor, "Peru's *Sendero Luminoso*: Peasant-Revolution or Andean Class War," Latin American and Caribbean Studies Center, Michigan State University, East Lansing, Michigan, 13 May 1992.

QUARTARARO, Anne T., Associate Professor, "Republicanism, Deaf Identity, and the Career of Henri Gaillard in late Nineteenth-Century France," First International Conference on Deaf History, Washington, DC, 19-22 June 1991.

SILLS, Chip, Assistant Professor, "The Situations of Skepticism," Session on Skepticism and Systematic Philosophy, Society for Systematic Philosophy, Eastern Divisional Meeting of American Philosophical Association, New York, New York, 27-30 December 1991.

SYMONDS, Craig L., Professor, "An Assessment of Confederate Generalship," USMC Art of War Studies, Quantico, Virginia, 2 September 1991.

SYMONDS, Craig L., Professor, "Joseph E. Johnston and the Defense of Vicksburg, 1863," Southwestern Historical Association Conference, Austin, Texas, 19 March 1992.

TUCKER, Ernest, Assistant Professor, "1722-1747: A Strange Period in Ottoman-Persian Relations," Middle East Studies Association Annual Meeting, Washington, DC, 15 November 1991.

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## Language Studies

Professor Gladys Rivera-La Scala  
Chair

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The Language Studies Department enjoyed a very strong year, with outstanding classroom and scholarly performance by faculty. Faculty members produced 11 articles on French, Spanish, Russian, and German philosophical, cultural, and literary topics and gave more than 40 presentations at national and international conferences.

In the field of language acquisition, the Annapolis Interactive Video Project faculty team won the prestigious EDUCOM 1991 national award for the best curriculum innovation in the humanities. The competition was open to over 600 colleges and universities in the United States. We continued to create interactive video lessons for intermediate French and Spanish, and established plans to develop lessons for Japanese, Chinese, and German. This project, funded by the National Cryptologic School, recently won another grant from the Department of Education.

The department has enjoyed strong enrollments in all languages and successfully expanded the Cox/Graubart overseas program and internship opportunities at U.S. embassies in France and Spain. With the addition of third-year Japanese to the curriculum, nine members of the class of 1992 have the distinction of being the first group of midshipmen to receive a minor in Japanese language and culture in recent Academy history. We are equally proud of the large number of minors in all languages (145) among 1992 graduates who have elected to pursue language, literature, and area studies at advanced levels. These graduates will bring to the Navy and Marine Corps not only valuable linguistic skills but also in-depth knowledge of the regions where a specific language is spoken.



## Sponsored Research

### Annapolis Interactive Video Project

Researchers: Associate Professor William H. Fletcher, Project Director, Assistant Professor Marianne Bosshard, Assistant Professor Christopher D. Buck, Visiting Professor Frank Buschgans, Assistant Professor Maria E. Castro de Moux, Associate Professor Eva L. Corredor, Associate Professor Audrey Gaquin, Associate Professor Elsa M. Gilmore, Professor John A. Hutchins, Associate Professor Ludmila A. Pruner, Professor Helen E. Purkitt, Professor Sharon Dahlgren Voros and Professor John D. Yarbro.  
Sponsor: National Security Agency

Since its inception in 1985, this project has expanded into a team of professors who compile videodiscs and author interactive video (IAV) lessons for Spanish, French, Russian, and German. Project members have developed delivery and authoring software for a standard approach to creating lessons and have produced extensive documentation to guide authors through the process: authors combine selections from a set of some twenty presentation and exercise template types into a lesson structure and provide lesson content in text, graphic, and "control" (script) files produced with USNA-developed authoring tools and commercial graphic software. The project team regularly shares its software and its IAV expertise with other Naval Academy departments, government agencies, and educational institutions.

In 1991, EDUCOM, a national educational computing consortium of almost 700 colleges and universities, selected the USNA project out of 116 entries to receive its prestigious Higher Education Software Best Humanities Entry Award. The EDUCOM judges and awards committee cited numerous specific strengths of the project. First and foremost were the innovation and consistently high quality of the courseware. Next was complete integration into the language curriculum through classroom and homework activities that specifically support lesson objectives. They were greatly impressed by the quantity and effectiveness of the instruction produced and by the extensive collaboration among 18 faculty and staff. Currently over 600 midshipmen are benefitting from some 120 IAV lessons in four languages. The faculty members who share the prize are: Professors Gladys Rivera-La Scala and Sharon Dahlgren Voros, Associate Professors William Flechter and Ludmila Pruner,

and Assistant Professors Christopher Buck, Maria E. Castro de Moux and Enrique Marquez.

In the past year team members have compiled four new videodiscs for French and German. Especially significant is the fact that agreements have been negotiated with the copyrights holders, which for the first time will permit distribution of the videodiscs and lessons developed by team members beyond U.S. government agencies. For the first time IAV lessons became a regular homework activity for intermediate French and French culture and civilization courses. The existing intermediate Spanish lessons were adapted to a new textbook and supplemented by four new lessons; and new written and oral pre- and postactivities were authored for many of them. The project's four-year evaluation of language acquisition via computerized IAV was concluded, and the final report is expected by August 1992. The basic lesson delivery and authoring software is being reprogrammed in C++ to support many improvements in lesson design, to permit widespread distribution of project software, and to enable delivery on a wider range of hardware configurations.

The Annapolis Interactive Video Project continues to expand the scope of its internationally recognized pioneering work. Under a grant from the Fund for the Improvement of Post-Secondary Education (Department of Education), the project is collaborating with Southwest Texas State University on developing IAV authoring templates which will run on both Macintosh and IBM-compatible hardware. When completed, these templates will permit an IAV lesson to run on a large percentage of the delivery equipment currently in place in higher education.

## **The Use of Technology in the Teaching of French Civilization**

Researcher: Associate Professor Eva L. Corredor

Sponsor: Naval Academy Instructional Development Advisory Committee

Research during the summer of 1991 into more than fifty satellite transmitted programs of France TV Magazine by the University of Maryland, Baltimore Campus, yielded a selection of about two-hundred video segments that have been classified by theme and are now being used at the Naval Academy as very useful and popular teaching supplements in courses on French civilization and modern France. From these materials the researcher selected specific video segments for the production of two

laser videodiscs on French civilization which are currently distributed by France TV Magazine at UMBC, entitled: "Documents et Monuments Historiques," for use in advanced French civilization courses, and "Aspects et Traditions du Terroir," for use in advanced courses on modern France. Some of the results of this project have been discussed in conference presentations at the Technical University of Budapest and Loyola College.

## **Interactive Video Lessons for Intermediate French**

Researchers: Associate Professors Elsa M. Gilmore and Audrey Gaquin

Sponsor: Naval Academy Instructional Development Advisory Committee

Interactive video lessons have been available in Advanced French, FF301-302, since 1986, and the large-scale Annapolis Interactive Video Project has developed weekly lessons for beginning and intermediate Spanish. Some interactive video programming for Russian is also in use.

Interactive video allows students to view video segments individually, in the language laboratory, as assignments. After viewing the segments, students complete on-screen computerized lessons designed to reinforce the students' listening comprehension skills and understanding of the target culture. With the technology developed by the Annapolis Interactive Video Project, students' comprehension is tested as part of the completion of each assignment, and the results are tabulated for their instructors. Interactive video frees class time for conversation practice and grammar explanation, as well as practice, reading, and composition work. Most important, each student has the opportunity to work at an individualized pace on the most challenging of the four language skills, listening comprehension.

During Spring 1991, the researchers compiled a list of ten themes occurring with high frequency in recently published intermediate French textbooks, in order to use these themes as a basis for video segment selection. The themes included: education,

food, the family, transportation and lodging, media, politics and society, the economy, problems of daily life, technology, and leisure activities.

In addition to providing intensive practice in listening comprehension, and freeing class time for the other activities mentioned above, the use of television segments, which provide appealing visual cues, motivates the midshipmen to make serious efforts to understand the accompanying speech, and provides clues to its content. As the closest substitute to direct contact with French people and their culture, the segments, involving political, social, economic, and cultural current events, bring contemporary France into the classroom and sharpen students' powers of observation and analysis. The accompanying lessons include lexical and cultural explanations, and both test and reinforce the information presented in the segments.

Students were asked to include on their end-of-semester course evaluations comments on their reactions to the interactive video lessons and their assessment of the effectiveness of the program. Investigators involved in earlier interactive video projects have been asked to inspect and evaluate the intermediate French project during summer 1992. The development of a video-mediated computer adaptive test to evaluate students' proficiency is not within the scope of the present project.

## **Interactive Video Lessons for Intermediate French**

Researchers: Associate Professors Elsa M. Gilmore and Audrey Gaquin  
Sponsor: Naval Academy Instructional Development Advisory Committee

Since June 1991 both researchers have co-produced a videodisc of authentic video materials. The segments were selected from recent France TV Magazine broadcast tapes with a view to complementing the cultural and linguistic content characteristic of a college-level intermediate French course. Interactive computer lessons stressing the development of listening comprehension skills have been written to accompany the segments. Professor Gilmore produced three which were used in 1991-1992: "Le TGV," "Gastronomie de Demain," and "Mangez du Pain!" Each of these lessons includes an innovative exercise. "Mangez du Pain!" and "Gastronomie de Demain" contain optional "cultural screens." These provide the student with social and linguistic information that should enrich understanding of the lesson. "Le TGV" includes a module which integrates the video lesson's context with related vocabulary previously presented in the

FF202 classroom. The following lessons are finished and will be integrated into the FF201-202 syllabus in 1992-1993: "La Ceinture Obligatoire," "Un Mariage Champêtre," "La Francoscopie," "Les Frivolités de la Mode," and "La Mode et l'Armée." Professor Gaquin produced four video lessons which were also used in 1991-1992: "La Laguna," "Une pension pour animaux," "Un petit village à l'honneur," and "Commune riche, commune pauvre." All of these used a new form of computer vocabulary quiz, asking students to match video segments containing specific words with a French definition of these words. "Un petit village à l'honneur" and "Commune riche, commune pauvre" explore different ways of introducing students to historical contexts in the computer lesson format. Five additional lessons will be completed in summer 1992 and incorporated into FF-201-202 syllabus in 1992-1993.

## **Pragmatic Exploitation of the Impersonal-[Se] Construction in Spanish**

Researcher: Associate Professor Penelope M. Bledsoe  
Sponsor: Naval Academy Research Council (OMN)

The researcher finds that the impersonal-[se] structure (a structure available to the language user in Spanish when the logical subject is unknown, generic, indefinite, or considered to be unimportant to the communication) occurs in seemingly anomalous contexts where the referent is definite and known to the speaker. The occurrence of an impersonal expression where a definite one might be expected is a reflection of politeness and formality conventions which require that in potentially embarrassing situations, the speaker should avoid specifying who is responsible for what action. This conversational strategy involves to a great extent the pragmatic notion of conversational implicature, which provides some explicit account of how it is possible to 'mean' in some general sense more than what is actually 'said.' An impersonal structure allows the speaker to refer to the subject indirectly and to avoid personal reference. The in-

tended meaning of the proposition is thus implied, not stated directly. In the contexts studied, the interlocutors are socially distant, and there is a discrepancy in power status. The most frequent non-standard occurrence of the structure is in implied imperatives, where a direct imperative or command would be inappropriate. In other instances, impersonal statements and questions of opinion may be made in order to avoid seeming to impose the speaker's will or opinion--and thus deprive the other party of courteous options for counter interpretations, disagreement, or non-compliance. Finally, the non-standard occurrence of the impersonal structure is indicated when a speaker does not want to associate anyone in particular with an assertion, because of the controversiality of the claim and/or fear of reprisal. An article on this topic is forthcoming in The Fall 1992 issue of *Hispania*.

## **The Pragmatic Exploitation of the Impersonal [se]-Structure in Spanish Oral Discourse**

Researcher: Associate Professor Penelope M. Bledsoe  
Sponsor: Naval Academy Research Council (OMN)

The researcher is preparing a book in Spanish linguistics on structures associated with the Spanish impersonal pronoun [se]. The bibliography of syntactic and semantic studies of this structure is quite extensive; however, these studies have been inconclusive as to the variability of the form of the structure itself, factors which determine its form, and contexts of occurrence of the form. The researcher has found that the form of the structure is influenced by factors determining distribution of information in the Spanish clause, not strictly by a syntactic movement rule. The choice of one form of the structure over another depends on how the structure is to be used in context. In a pragmatic framework, the study explains the apparent anomalous occurrence of the impersonal-[se] structure in contexts where a definite referent would be expected. It was found that in certain social and cultural contexts it occurs to sustain sociolinguistic principles of communication where polite and formal language prevails. It occurs as an effort of the language user to shift responsibility and/or blame away from a logical subject.

Four chapters on the structure have been completed, and the researcher has been awarded a NARC grant to complete the final chapter which addresses the occurrence of the impersonal-[se] structure in spoken discourse. The manuscript should be completed by fall 1993.

## **Chantal Chawaf: A Plea for New Ethical Values in Literature**

Researcher: Assistant Professor Marianne Bosshard  
Sponsor: Naval Academy Research Council (OMN)

This project is intended to result in a book-length critical analysis of the oeuvre of Chantal Chawaf, one of the better known contemporary women novelists whose literary style belongs to a tradition commonly referred to as "écriture au féminin."

In the current "post/post-structuralist" era of literary and philosophical theory, Chawaf's "écriture," which attempts to include an "interior, affective intelligence," places her again, as it did in the 1970's, at the center of linguistic and philosophical debates. Chawaf's work has attracted renewed attention, in particular within the context of "gynocentric" writing. Thus, topics that are of concern to Chawaf in the fields of communication, of bipolar and hierarchical thinking with respect to body and mind and the affective and social domains, have regained importance within the framework of the current search for new ethical values in literature.

Since 1974, Chawaf has published one novel per year; a script for a play, and numerous theoretical articles, as well as a theoretical essay which was published in February of 1992. To date, no comprehensive critical text of her work is available, either in this country or in France. With this project, the researcher intends to make available a much needed critical tool for the study of Chantal Chawaf's works.

During the summer of 1992, the researcher will revise and update her dissertation (1988), incorporate conference papers and articles on the author's most recent works, and provide the manuscript with an updated critical bibliography.

During meetings with the author in Paris and Strasbourg, planned for June 1992, the researcher hopes to add an interview with Chawaf pertaining to the most recent developments in the author's literary agenda.

## **Luis Palés Matos and his Black Poetry**

Researcher: Assistant Professor María E. Castro de Moux  
Sponsor: Naval Academy Research Council (OMN)

Luis Palés Matos, a Puerto Rican poet from a middle class, white family, is well-known for his Afro-Antillean poems. Researchers in Puerto Rican

literature have been intrigued by the fact that a good portion of Palés Matos' writings are related to African influence in the Antilles. Current criticism



has not been able to explain the disparities of style and topics between his Black poetry and his White poems. To explain these differences, this study explores the relationship between socio-economic conditions in Puerto Rico and Palés' writings. Biographical data point to a possible link between the death of Palés' father and the impoverishment of his family due to the gradual economic deteri-

oration of Puerto Rican society. In addition, Luis Munoz Marin, a political leader of Matos' time, and social readings had an impact on the poet's attitude towards literature and the kind of poetry he wrote during the 1920's and 1930's. The first two chapters are finished. The revision of two more chapters should be completed by the end of the summer of 1992.

### **White Western Philosophy and Psychology in Black American Fiction: A Re-reading of Toni Morrison's *Sula***

Researcher: Assistant Professor Monika Hoffarth-Zelloe  
Sponsor: Naval Academy Research Council (OMN)

Although many articles and books have been published on Morrison's six novels, no one has researched so far the hidden Western philosophical and psychological elements in her fiction. This topic is especially relevant in the current debate among Afro-American scholars regarding Henry Louis Gates' book *The Signifying Monkey: A Theory of Afro-American Literary Criticism*. In this study, Gates applies the Western post-structuralist inquiries of Paul de Man, Jacques Derrida, and Geoffrey Hartman to Afro-American fiction, suggesting new directions for critics and teachers of Afro-American

literature to pursue.

The scholarly debate about using Western approaches to gain a better understanding of Afro-American texts, as well as a personal meeting with Henry Louis Gates, has inspired the researcher: (a) to determine in what way Morrison's texts resemble Western texts, (b) to examine more specifically to what extent she employs philosophical ideas and psychological theories inherent in the Western tradition, and (c) to interpret her novels from a white Western female perspective.

### **Readability and Intertextuality in Balzac's Fiction**

Researcher: Assistant Professor Elizabeth Knutson  
Sponsor: Naval Academy Research Council (OMN)

This research project investigates the relationship between narrative intelligibility, genre, and intertextuality in three novels by Balzac representing the genres of melodrama, realism, and the fantastic. The research includes examining previous studies of significance relating to conditions of narrative intelligibility: text characteristics such as redundancy, overdetermination of meaning, and homogeneity vs. paradox, complexity, and heterogeneity. The question of readability leads directly to a consideration of generic norms, since a text makes sense above all in terms of conventions relating to its genre. Signs of genre are evident not only in narrative structure itself, but also in titles, prefaces, and intertextual references. Such signs are directions for reading, as a text may establish its identity through comparison to other similar or dissimilar texts. The study addresses the readability of each of Balzac's three texts in terms of their in-

ternal coherence, redundancy (or lack thereof), and relative conformity to recognized conventions of genre.

Text characteristics such as uncertainty or modalization in the narrative voice, for example, are a normal phenomenon for the fantastic genre. Realist narrative, on the other hand, is readable in terms of completely different conventions: conformity to cultural codes, or what readers of a particular time accept as social "reality." Melodrama, while not conforming to the codes of cultural verisimilitude, is highly readable in terms of its conformity to literary formulae (hyperbole, theatricality, manichaeistic structure). Wherever Balzac's texts do not conform to generic conventions, the question is raised as to whether or how, in the interest of readability, such deviations are compensated for in the narrative structure. Finally, intertextual references in each novel are

analyzed to determine whether they function to increase narrative intelligibility or whether, on the contrary, they draw the reader's attention away from the story and invite a metafictional reading. The research has resulted in the drafting of an article

focusing on readability as it relates to generic norms in general, to be followed by a second article focusing more specifically on the relation between intertextuality and readability in the novels by Balzac.

### **Adjuvancy and Opposition: A Study of Supporting Roles in Pedro Calderón de la Barca (1600-1681)**

Researcher: Professor Sharon Dahlgren Voros  
Sponsor: Naval Academy Research Council (OMN)

This book-length study combines the methodology of semiotics with archival research on Pedro Calderón's secular and religious drama. While supporting or secondary roles are often overlooked in drama studies, they provide keys for interpreting the playtext, since they complement and comment on the action of the main characters. Adjuvancy and opposition, terms from A. J. Greimas' semiotic model, imply actantial functions of characters of subordinate social rank, and hence often marginalized figures. The researcher made a presentation on feminine roles of adjuvancy in the character Flor, an allusion to the Roman goddess Flora of dubious reputation. Flor's intentions are misinterpreted by male leading characters, as they assume her to be an opposant. Flor's self-assertion generates the stage action responsible for the play's structure. This methodology extends also to minorities. In a forthcoming article, "Discovering Moorish Women in the Spanish Classical Drama,"

the researcher approaches Calderón's history play dealing with the Moorish rebellion of 1570 in the Alpujarras region of Granada. While Moorish men are studied, since they are historical figures, the secondary women's roles are largely fictionalized and in need of investigation. Calderón condemns the greed and brutality of Spanish soldiers, while he still supports the imperial politics of the Hapsburg reign.

The researcher will conduct archival research this summer into literature read by women in the seventeenth century, the *exempla* books, such as Boccaccio's *De claris mulieribus* and *Lives of Saints*, since they give models for feminine behavior. Also to be explored are edicts on women's dress codes, such as the prohibition of veils to be worn in the streets, first an edict against Muslim women and then against all women. Such information will bring historical data on clothing that influenced staging and acting, as well as revealing details on social and gender-coded behavior.

## Independent Research

### Subject Inversion in Spanish and Narrative Style: A Case Study of [*Los de abajo*]

Researcher: Associate Professor Penelope M. Bledsoe

The proposed functional value of subject inversion in Spanish is that of focusing the subject NP. This non-contrastive and non-emphatic subject focus is achieved by placing the subject NP in clause-final position, where it is appropriately highlighted by normal sentence stress. The typical clause configuration resulting from this inversion is: (temporal or spatial adverb) + verb + subject NP + (postmodification). In a discourse, the function of this construction, sometimes referred to as 'existential' or 'presentational,' has been identified by Hatcher, 1954; Contreras, 1978; and Suñer, 1984, as asserting the existence of subject.

The researcher addresses the function of the focused subject NP and the existential or presentational clause of which it forms a part in a narrative. By examining its occurrence in *Los de abajo*, it is shown that this construction with post-

posed subject brings subject NP's, both animate and inanimate, into focus as simply being or existing. The verbal and adverbial phrases simply serve as devices for getting the subject NP onto the scene and situating it in time and space. Passages from the novel are used to illustrate this function.

In particular, it is shown how Azuela exploits this structure in a narrative replete with action and violence to slow down the action and give the reader a respite in a world he paints as otherwise peaceful and beautiful with splendid descriptions of vistas and sounds. The author 'paints' scenery with the construction exactly as Hatcher describes in her seminal study of the existential sentence.

The results of this research will be presented at the Northeast Regional Conference of the American Association of Teachers of Spanish and Portuguese at Hampshire College in September 1992.

### The Function of V-S Word Order in Spanish

Researcher: Associate Professor Penelope M. Bledsoe

The objective of this research is to show that a communication-based theory which is based on the notions of salience, highlighting, and context of occurrence, can explain and account for subject NP postposition in Spanish. It is argued that postposition is a kind of marking device; it marks the subject NP as communicatively salient. A subject-focus structure is created by virtue of the occurrence of the NP in neutral stress and focus position in the Spanish sentence. Subject NP's are more salient in this position not simply because they are out of default pre-position, but because they are in the position of sentence stress and focus.

The researcher examines and describes the properties of such a structure at the lexical, sentence, and discourse levels. At these levels, the

following questions are addressed: At the lexical level, are there specific classes of noun phrases and/or verbs which may enter into the verb-subject (V-S) structures? At the sentence level, what role does stress and/or word order play in the assignment of focus in Spanish? And at the discourse level, in what contexts is a clause with a postposed focused subject NP appropriate, and what if any restrictions or constraints apply to its occurrence in a context? And finally, what is the nature of these constraints?

The findings of this research will be presented at the 1992 Annual Meeting of the American Association of Teachers of Spanish and Portuguese in Cancún, Mexico, in August 1992.

## Languages

Researcher: Associate Professor Penelope M. Bledsoe

The researcher has completed a review and revision of an entry on a general introduction to the nature of language, languages of the world, language families, theories of the origins of language, and the field of linguistics as the study of language. This entry, along with charts and graphics designed by the researcher, will appear in the 1993 edition of the

encyclopedia. Her name and institutional affiliation will appear at the end of the entry and in the list of contributing authors at the end of the tome in which the entry appears (New Book of Knowledge Encyclopedia, Grolier, Inc., forthcoming in 1993 edition).

## Types of Dramatic Discourse in the *Entremés de los negros* by Simón Aguado

Researcher: Assistant Professor Maria E. Castro de Moux

Spain's Golden Age Theater has a wealth of short plays (*entremeses*) that have not been studied, as well as the longer plays (*comedias*). These short plays reveal social relations through humor, providing startling confrontations of deep-seated racial and political problems.

Based on Juan Villegas' model of dramatic discourse, the article analyzes the conflicting relationship between speech and social status, slave owners and black slaves. Although the human rights debate of Indians and Blacks had lost impact among theologians in the early seventeenth century, various

characters in the play voice their rights to humane treatment and freedom. There are two political discourses in conflict: the dominant discourse of the defenders of the Empire and the displaced liberal arguments of priests and missionaries who defended the right to freedom. In the play, the slaves use Catholic theological, philosophical, and legal arguments to further their rights and subvert an unjust social order. The slaves, however, end up by accepting the rule of their masters and by adopting their owners' dramatic discourse. Thus, the discourse of the enslaved is silenced at the end.

## Aristotle's *Politics* in *Fuente Ovejuna*

Researcher: Assistant Professor María E. Castro de Moux

Lope de Vega's *Fuente Ovejuna* explores class differences, and the underlying causes for revolts and revolutionary movements. In creating a collective hero, Lope anticipates the social theater of the twentieth century. However, the hierarchical system survives in the play. After killing the cruel lord, the peasants accept monarchical authority and power. The king restores harmony between the opposing groups through law and just decisions. Aristotle's *Politics* provides the ideological background for the complex dramatic discourse. In the end, the moderate solution to revolutions prevails as

the result of just government decisions by the monarchs.

This paper studies intertextual relations between *Fuente Ovejuna* and Aristotle's *Politics* established by Lope's reference to Aristotle's work as a key to understanding Lope's political ideology. Although the play dramatizes a Castilian revolt of the fourteenth century, contrary to recent critical opinions, the play is not revolutionary in its solution. The play does not end with the creation of a republic, but with the peasants' subordination to the monarchy, as the constituted authority.

### **Pícaros e Indianos: Types of Dramatic Discourse in the *Entremés del Platillo* by Simón Aguado**

Researcher: Assistant Professor María E. Castro de Moux

Taking Juan Villegas' model of dramatic discourse analysis as a point of departure, the researcher studies the relationship between speech and social status. The conflict between two Spanish rogues (pícaros), who reject a returned immigrant (Indiano) with his newly-acquired wealth, is explored in the play. At the beginning of the play, the marginal discourse coincides with the marginal social status of the pícaros. But as they encounter the 'Indiano,' the pícaros' discourse incorporates the

fundamental premises of the aristocracy and, thus, their discourse serves the interest of the Spanish elite of the period and not that of their own class. The original marginality of the text is set aside while the 'Indiano' in a snobbish attempt to belong, imitates unsuccessfully the speech of the upper classes. The pranks and thefts of his property are justified by the presumption that he may be of Jewish descent.

### **Contemporary Autobiographical and Exile Literature**

Researcher: Associate Professor Eva L. Corredor

This project was begun in 1989 with the help of a NARC grant. In May 1991, during a personal leave of absence, the researcher was able to pursue this ongoing project by conducting interviews in Paris with two significant contemporary writers, Serge

Doubrovsky (*Le Livre brisé*, Prix Medicis 1989) and Tahar Ben Jelloun (*La Nuit sacrée*, Prix Goncourt 1987). Her article on Maghrebian exile fiction is forthcoming in *The French Review* in December 1992.

### **Confrontations with György Lukács**

Researcher: Associate Professor Eva L. Corredor

This is a manuscript of about two-hundred pages consisting of a collection of papers presented at professional conferences and a few previously pub-

lished articles on György Lukács to which the researcher has added an introduction in 1991. It is intended for publication in book form.

### **Lukács after Glasnost**

Researcher: Associate Professor Eva I. Corredor

This project was inspired by the recent ideological and political revolutions in Russia and Eastern Europe. It constitutes a reevaluation of the Hun-

garian philosopher and literary critic György Lukács' theories in the light of these events. The results will be published in book form.

### **Aspects of Basque Syntax**

Researcher: Instructor Ana I. Echavarri-Dailey

In linguistics, the theoretical framework which has come to be known as the principles and parameters approach was introduced by Chomsky in *Lectures on Government and Binding* (1981); this approach concentrates on the general principles, constraints, and parameters that might indicate how language

acquisition takes place. The (G)overnment and (B)inding model (G.B.) is based on the belief that language is a cognitive system, which is in large part innate and, as such, part of our biological endowment. This conception of language motivates the quest for the principles of universal grammar

(U.G.) that form part of our language faculty.

The researcher's Ph.D. dissertation, "Aspects of Basque Syntax," is a study of grammatical constructions in Basque which exhibit behavior uncommon to other languages and which are therefore difficult to explain within the G.B. model. One of the chapters is entitled "Focus in Basque."

The relevance of focus in the structure of the Basque language was first noted by Severo Altube. In his book *Erderismos*, he noted that in Basque, the focused element of a sentence must be placed immediately before the verb. Current linguistic research, building on this study, has concentrated solely on postulating a preverbal syntactic position to which the focused element must move in Basque. This approach ignores other focusing strategies, and so far has not been able to explain the problem of focus in negative sentences.

During the summer 1991 the researcher observed that in addition to the main focusing strategy men-

tioned by Altube and others, there are other strategies, similar to the ones used in Spanish or English that are very common in Basque: right dislocation, left dislocation, and in some cases postverbal placement of the focused element. At that time the researcher concentrated on the type of focused elements that can be placed postverbally.

For the study period ending in September 1991, the researcher has outlined a possible explanation for focus in Basque negative sentences, a persistent problem for any analysis that proposes a unique syntactic preverbal focus position. In Basque negative sentences the focused element is placed postverbally, but before the inflected auxiliary. The researcher believes that there exists a second position in Basque, reserved for contrastive purposes, and it is to this position that focused elements in negative sentences must move because of their contrastive nature.

## Elements of Theoretical Linguistics in Priscian's *Institutiones*

Researcher: Associate Professor Audrey Gaquin

Twentieth-century linguistics, judging from a strictly modern point of view, dismisses Priscian's work as unscientific, lacking in method, and irrelevant to the progress of modern linguistics. Yet Priscian's place at the end of the long tradition of classical grammar, building on the work of his many predecessors and functioning as a principal source of information for medieval grammarians, points up his importance for the western grammatical tradition.

An examination of Priscian's *Institutiones* shows that this work made available to his successors certain fundamental theories on the nature of language, as well as doctrines about specific grammatical points. The presentation of the different levels of language and definitions of the noun and verb represent the most extensive theoretical discussions in Priscian's work. These discussions stress the importance of the semantic component in language production.

Priscian's discussions of specific subcategories of

the parts of speech, such as the paradigm for the reflexive pronoun *sui*, the formation of interrogatives, and the treatment of other types of "understood" elements in language, help to define the semantic component as a set of what may be called semantic wholes. These semantic wholes are matched with corresponding language forms, most of which, in turn, are generated by a smaller class of primary forms. The study of the semantic aspects of his theory promises to be useful not only for understanding classical linguistics, but also for evaluating Priscian's contribution to the medieval grammatical tradition.

This monograph is a re-working of the researcher's Ph.D. dissertation. It has been solicited for publication in the John Benjamins series on History of Linguistics. The researcher has nearly completed the bibliographical update, and the majority of the necessary revisions have been completed. The manuscript should be submitted for a preliminary review early in 1993.

## A Different France: Documents from the Minority Cultures of France

Researcher: Associate Professor Audrey Gaquin

*A Different France* is an anthology of documents from the seven regions of France whose inhabitants are considered 'minorités installées,' that is, members of a group whose native language and culture are different from those of the French nation. These include Alsace, Basque country, Brittany, Corsica, Flanders, North Catalonia, and Occitania. The Mitterrand government has passed laws allowing greater regional autonomy in all of France, including greater freedom of expression for members of cultural minorities. Autonomist and separatist groups in some of these areas, while not attracting many members, receive wide support from the minority population; for example, a member of the Corsican autonomist group UPC, Max Simeoni, is now a delegate to the European Parliament. The abolition of economic barriers in the European Economic Community in 1992 is also an important factor in the way minorities respond to the initiatives of the French government.

The regionalist movement in France and its consequences for the minorities have received little

attention outside of France. Indeed, it is difficult to obtain even basic information about these minorities in the United States. *A Different France* makes available to students, teachers, and scholars primary source materials relating to the regional cultures of France. One section of the anthology is devoted to each of the seven minorities, and each section includes a historical introduction, an interview with a minority leader, articles on the political and economic issues concerning the region in question, sample lessons in the minority language, brief literary selections in the minority language, with translations into French, and information about customs, traditions, and folk art in the region.

Publication of *A Different France* has been delayed, due to the time consumed by obtaining permission to reprint 50 documents in the anthology. The permissions have now been obtained, and the publisher has authorized the researcher to proceed with manuscript preparation. The manuscript will be submitted to the publisher in summer 1992.

## Structure and Ambiguity in *Our Daily Secret Obscenities* by Marco Antonio de la Parra

Researcher: Associate Professor Elsa M. Gilmore

This article explains the structure of de la Parra's best known play by focusing on its ambiguity. The researcher studies this characteristic in relation to the 'atomistic' model put forth by Gilles Deleuze and Félix Guattari in their classical study *Anti-Oedipus*. As in Deleuze and Guattari's psychological model, *Our Daily Secret Obscenities* bases its structural coherence not on a single motivational complex or a single semantic level, but on many.

The text's 'unity' is derived from the complementary and/or contradictory interaction between these competing elements. The discussion focuses principally on the role of ambiguity in multiple characterization, in socio-political commentary, and in tragic-comic effect. The article has been accepted for publication by the *Latin American Theatre Review*.

## New Cuisine: The Theatre of Marco Antonio de la Parra

Researcher: Associate Professor Elsa M. Gilmore

In this study of Marco Antonio de la Parra's controversial *The Raw, the Cooked, and the Rotten* (1983), the researcher analyzes the play's constant veiled references to Chilean history. She interprets the 'absurdist' dramatic text as one which evokes Chile's evolution from social democracy to military dictatorship and which anticipates the end of the Pinochet regime. In view of de la Parra's more re-

cent works, the researcher also offers up *The Raw, the Cooked and the Rotten* as the critical point of departure from which later plays step into a full-fledged postmodern esthetics. An article on this topic is forthcoming in an English language de la Parra anthology edited by Dr. Charles Thomas of the University of Wisconsin.

### ***Unwiederbringlich: A Fontanesc Christmas or Midsummer Play?***

Researcher: Associate Professor Sylvain Guarda

Through careful analysis of the main characters, Christine and Holk, and with a focus on Holk's journey into the underworld, this study explains Christine's suicide at the end of the novel and declares *Unwiederbringlich* a Midsummer play (June 24 celebrated as the feast of the nativity of John the

Baptist). The novel is then discussed and linked to Grillparzer's *Des Meeres und der Liebe Wellen* (1831) to which Fontane pays a tribute. The manuscript has been accepted for publication by the *Zeitschrift für Deutsche Philologie*, Germany.

### ***Die Poggenpuhls: A Cabalistic Michaelmas Play in Jewish Vestment***

Researcher: Associate Professor Sylvain Guarda

This essay argues that Fontane's penultimate novel, *Die Poggenpuhls* (1896), erroneously characterized by many Fontane-scholars as "the mere ghost of a novel" because of its most questionable shape, should not be read as realistic entertainment or as a record of overheard conversations of the time, but

as a cabalistic thaumaturgy. This new reading not only does justice to the novelty of Fontane's unconventional narrative but also highlights the author's familiarity with Jewish theosophy and its rituals.

### **The Language of Diplomatic Correspondence between Moscow and the Turkic Khanates: 1458-1600**

Researcher: Instructor Dudley Hagen

The documents being examined for this doctoral dissertation at the University of California, Los Angeles, are a series of notes, drafts, and treaties. They were published in the middle of the last century. All of the documents are in Russian, but about half are translations from Tatar. The researcher is making a detailed analysis of the language of both types of documents, and bringing

in linguistic facts from comparable documents preserved in the Tatar. The analysis is intended to show that the Muscovite diplomatic language, which was still taking shape at this period, was under strong Tatar influence. Recent work by historians of Russia has suggested that Moscow's political institutions and statecraft were influenced in the same way.

### ***Alien Voices in the Journey of Afanasij Nikitin***

Researcher: Instructor Dudley Hagen

Afanasij Nikitin was a fifteenth-century Russian merchant who left a vivid, and sometimes baffling, account of his journey to India. The work is significant, because it is the first traveler's account in Old Russian literature that does not belong to the genre of pilgrimage. Over the centuries the author of this work has been seen as a Russian patriot, a goodwill ambassador to oppressed peoples, a literary artist (in Trubetskoy's celebrated analysis),

or most recently as an apostate who converted to Islam to save his life and turn a profit. The researcher's study of the political and cultural relations between Russians and Tatars has made it possible to answer certain open questions about Afanasij's language. In this light, the linguistically hybrid text suggests that the author of the *Journey* was a member of a transitional Islamic-Orthodox cultural community.



## **Resolving the Paradox - An Interlinear Reading of Toni Morrison's *Sula***

Researcher: Assistant Professor Monika Hoffarth-Zelloc

This article exposes the reader's difficulty in extrapolating a message from Morrison's novels. The interpreter's reading process is rendered difficult due to the constant paradoxes which Morrison strategically employs. In her narrative *Sula*, Morrison seems to speak to us through Sula, an independent, free-thinking woman. Yet, what Sula says and what Morrison really means become an enigma. Like many African-American authors,

Morrison uses figurative language and paradoxes to say one thing and mean another. Reader perception versus reader manipulation comes into play. Which values does Morrison really support? Suggesting an interlinear reading approach, this article elaborates ways to resolve the paradoxes with which the reader is left (accepted for publication by the *Journal of Narrative Technique*).

## **Where is the Text? Discourse Competence and the Foreign Language Textbook**

Researcher: Assistant Professor Elisabeth M. Knutson

This study examines the relationship between theory of discourse competence and the representation of oral language in commercial foreign language materials. The study begins with a review of research on discourse competence from pragmatic, socio-linguistic, and second language acquisition perspectives, focusing on concepts of discourse as text cohesion/organization, conversation management, and interactional competence. The researchers then analyze the implicit assumptions about discourse which are reflected in the grammar explanations, oral exercises, and dialogue samples of seven widely-used French-language textbooks. The emphasis on production (rather than comprehen-

sion) and the privileging of sentence (rather than text) which characterize these materials result in a 'discourse-poor' environment for the learner. The researchers argue for the incorporation of longer samples of oral and written text, as well as presentation of grammatical structures and speech acts from a discourse perspective.

This article, co-researched and co-written with Marsha A. Kaplan of the Foreign Service Institute, has been accepted for publication by the Maryland Foreign Language Association, to appear in Volume II of *Proceedings of "Bridging Theory and Practice"* Conference held at Loyola College in 1991.

## **Second Language Acquisition of English Reflexives by Japanese Speakers and Japanese Reflexive 'Jibun' by English Speakers**

Researcher: Instructor Chiyo Myojin

This study explores the acquisition process of English reflexive pronouns and the Japanese *Jibun*, using and extending the first and second language acquisition parameters set forth by Wexler and Manzini in 1987. In a first step, the researcher examines how Japanese and English learners of the respective languages set values of the governing category parameters. Then, she investigates whether learners observe the Subset Principle (Berwick 1985) and succeed in acquiring the correct L2 value or whether they unsuccessfully transfer their L1

value to the L2 grammar and adopt a value which is that of neither the L1 or the L2. Even though the Subset Principle is not available to L2 acquisition, the researcher's findings show that Universal Grammar (Chomsky 1981, 1986, 1989) can be used in support of Wexler's and Manzini's hypothesis, according to which learning principles and UG, although pertaining to different modules, can interact with each other under specific circumstances.

## **Ivan Elagin--Truth, Satire, and Russian Literature**

Researcher: Associate Professor Ludmila A. Pruner

Ivan Elagin is one of the most prominent and honest poets of the so-called Second Wave of the Russian emigration related to the forced exile during the Stalinist terror in Russia. Despite the fact that his work was never acknowledged, and his poetry was never published in Russia, his name is familiar to many scholars and readers in the former

Soviet Union. The researcher pays tribute to the last decade of Elagin's life and work. The article analyzes the poet's outlook on the history of Russian literature and the genre of satire in particular, in light of Elagin's own personal experience in Russia before his exile and career in the United States.

## **Juan de Mena's *Coplas de los siete pecados mortales*: Second and Third Continuations: A Critical Edition and Study**

Researcher: Professor Gladys Rivera-La Scala

This book includes the first critical edition of the Second and Third Continuations of the *Coplas de los siete pecados mortales*, left unfinished at Juan de Mena's death, and an intertextual analysis of the main poem and its three continuations. The first chapter contains a comparative study of the four works based on themes, imagery, meter, and rhyme. In the second chapter, the author gives detailed, firsthand descriptions of the manuscripts and sixteenth-century printings used in establishing the base text and discusses the interrelationships that

exist between the many versions of the works. A corrected version of the continuations in modern script follows. Editorial, literary, and linguistic notes comprise the next section which ends with a glossary of medieval Spanish terms and one of proper names. Included in this volume is an extensive bibliography of primary and secondary source materials on Spanish and European fifteenth-century didactic poetry. The author has a publication contract with *Studia Humanistica*.

## **Juan de Mena's *Laberinto de fortuna*: A Critical Transcription and Concordance of ESP. MS 229 of the Bibliothèque Nationale, Paris**

Researchers: Professor Gladys Rivera-La Scala and  
Assistant Professor María Castro de Moux

This work will be published by the *Hispanic Seminary of Medieval Studies*, University of Wisconsin-Madison as part of their National Endowment for the Humanities-sponsored project, and the lexicon from the concordance will be included in the first *Dictionary of Old Spanish*, the first volumes of which are scheduled for dissemi-

nation in the early 1990's. This thirty-year project, begun in the late 1950's by Professor Lloyd Kasten, has enjoyed yearly support from the National Endowment for The Humanities for over 10 years and the expertise and work of at least two generations of scholars from the national and international communities.

## **Thomas Kyd and Pedro Calderón: The Semiotics of Feminine Performance**

Researcher: Professor Sharon Dahlgren Voros

This comparative approach to Golden Age Spanish Drama and Elizabethan Drama shows the similarities in performances of female characters, Flor in Calderón and Bel-imperia in Kyd, representing the legitimate political power in an age

of social change. The researcher bases the analysis on the relationships between sign and object crucial to staging in the theories of Charles S. Peirce and Algirdas Greimas. The Comparative Semiotic Model isolates three performance codes, derived

from the model of Paul Laivaille, involving macrosigns (Greimas) based on the mythological figure of Flora and microsigns (Peirce) based on gestural codes. This semiotic model is designed to further understanding of feminine performance codes that characterize the national theaters of both

Spain and England. The article has been accepted for publication by *Proceedings of the Parallel Lives Reunion: An Interdisciplinary International Symposium on English and Spanish National Drama, 1580-1690*.

**Feminine Symbols of Empire in Thomas Kyd and Pedro Calderón:  
*The Spanish Tragedy* and *De un castigo, tres venganzas* (By one  
punishment thrice revenged)**

Researcher: Professor Sharon Dahlgren Voros

Political ideology and its literary symbols have long concerned scholars of Spanish and English national dramas. This study examines feminine discourse and its symbolic value with a system of comparative semiotic models, based on the theories of Charles S. Peirce and Algridas Greimas. Even lyrical interludes in these plays are charged with ideological significance referring to notions of empire. Common to both dramatists are the Senecan revenge drama themes of corruption in the Court and the lack of communication between

reigning aristocrats and their subjects.

Women's roles are problematic, since they influence the course of action for vengeance. The semiotic model makes clear that women are not marginalized from central political concerns but, through their performance signs, are integrated into the main action of the play and contribute to the understanding and interpretation of these political texts. This work has been accepted for publication by *Pacific Coast Philology*.



## Research Course Projects

### Puerto Rico: Where Does Its Future Lie?

Researcher: Midshipman 1/C Manuel M. Burga, USN  
Adviser: Assistant Professor María E. Castro de Moux

This project explores current problems that Puerto Rico and the United States are facing in reaching an agreement as to the island's future. The paper examines the three available options: statehood, independence, or commonwealth status. The main sources for the research were Congressional debates, current legislation, interviews with Congressional lobbyists, officials from the Office of

the Governor of Puerto Rico, and scholarly articles and books on the subject. The analysis of sources leads the researcher to the conclusion that statehood is not an economically feasible option for Puerto Rico. In addition, cultural and linguistic barriers would make the incorporation of the island into American mainstream politics and life even more difficult.



## Publications

BLEDSON, Penelope M., Associate Professor, "Constraints on the Position of the NP in Spanish [Se]-structures," Selected *Proceedings* of the Thirty-ninth Annual Mountain Interstate Foreign Language Conference, October 1991, pp. 155-161.

This article offers a functional explanation for the existence of and special properties of some movement rules for Spanish, in particular, the subject postposing rule which postposes the subject NP to the verb. The researcher argues that positioning of the NP in the [se]-structure responds to discourse factors--presupposed or topical subject NP's are in pre-verbal position and focused NP's being introduced or reintroduced into a discourse are post-verbal. This post-verbal position is the position of prominence in the Spanish clause. This study offers an explanation of the extraordinarily high incidence of postposed subject NP's in the [se]-structure as a result of the impersonal pronoun's syntactic function; it changes the valence of a transitive verb from two to one. This remaining NP (the logical object) becomes the new subject, and is free to move around the verb, creating a situation similar to that of an intransitive structure, where the positioning of the NP in Spanish is determined by the function of the utterance in a discourse.

BLEDSON, Penelope M., Associate Professor, "Performance and Evaluation of Communicative Skills: The Video Camera in the L2 Classroom," *Hispania* 75 (Spring 1992), 202-205.

This study addresses the issues of material development, testing, and evaluation of communicative skills and offers some practical solutions which have proved to be applicable and successful in a college-level foreign language classroom with role-playing techniques, realia, and a video camera. It provides a detailed explanation of each step of the technique, including pedagogically-sound procedures designed to reduce performance anxiety and to create a positive affective environment in which the student will work and perform. Since these tasks are performed and video taped, sociolinguistic competence can be evaluated as well. The article suggests activities, realia, allotment of class time for practice, as well as a point scale for evaluating the performance. The value of the video camera as a performance indi-

cator and a motivational tool is discussed at length.

FLETCHER, William H., Associate Professor, Discussant Comments on "Language Pedagogy and Effective Technology Use" by Nina Garrett and on "Software for Language Training: Directions and Opportunities" by James P. Pusack. *Proceedings* of Conference on Improving Foreign Language Teaching Through Technology. Ed. William J. Bramble and David L. Hosley, Orlando, Florida, (1991), pp. 23-28 and 69-73.

These contributions present significantly revised and amplified versions of transcripts of the author's comments on two conference presentations on technology-assisted language learning. In his comments the author relates general and theoretical statements by the presenters to experiences of the USNA interactive video project team. The author stresses the conviction that computers alone are insufficient to teach learners to communicate in a foreign language; interaction with technology-based instruction should be but one link in a chain of interactions among students and instructor. He also believes a computer-assisted instruction should aim more for acquisition of learner strategies transferable to other contexts than for mastery of given linguistic information. In addition, the author supports an eclectic approach in technology-assisted instruction to address the needs of students with a variety of learning styles. On the issue of learner versus program control in computer-based lessons, he describes the experience at USNA that, especially in the beginning, learners want and need firm guidance from the program. Consequently, he argues for a model which emphasizes the computer's function as an 'instructional' tool, not as a 'learning' aid. On the subject of authentic video texts, the author stresses the linguistic and cultural richness and great student interest in well-chosen materials originally intended for native speakers and points out that learners can deal with surprisingly sophisticated video clips which are enhanced by aids to comprehension and tasks leading from comprehension to communication. The author champions an open-architecture approach to software, permitting end-users to customize courseware to their own needs, and discusses the advantages of well-designed authoring templates.

FLETCHER, William H., Associate Professor, "Interactive Video with Authentic Material for Elementary and Intermediate Spanish," *Learning to See: Seeing to Learn: A Colloquium on Interactive Video, 1-4 June 1989, University of Massachusetts, Amherst. Selected Papers*. Ed. Robert Smith, Mary Ann Lyman-Hager, and Elizabeth H. D. Mazzocco. Amherst, Massachusetts: Five Colleges Inc., (1991), pp. 17-22.

This article describes the interactive video (IAV) foreign language lessons developed at the United States Naval Academy based on commercial television from Spanish-speaking countries. Broadcasts from abroad are received via a satellite dish, and brief clips are selected and committed to videodisc to permit their use in computer-based interactive video lessons. Various techniques developed by the USNA IAV team to facilitate understanding and retention of these authentic video texts are discussed in detail from both a practical and a theoretical viewpoint. The methodology pioneered by this team has proved highly successful in enhancing students' comprehension of native-speed language and in helping them develop listening strategies. Approaches to integrating and exploiting the video lessons in the classroom are described, and a four-year study of the effectiveness of interactive video is outlined.

GUARDA, Sylvain, Associate Professor, "Theodor Fontanes *Cécile*: Die Weihe des 'Augen-Blicks' als geheimnisvolles 'Schau-Spiel'," *Michigan Germanic Studies* 17, 2 (Fall 1991), 128-149.

This essay offers an in-depth, critical appreciation of Theodor Fontane's novel *Cécile* (1884), heretofore regarded by most experts as a by-product beyond redemption. Aside from demonstrating intertextual relationships and structural similarities between *Cécile* and the author's internationally known "masterpiece," *Effi Briest* (1894), it points to recurring themes that not only shaped Hugo v. Hofmannsthal's novella *Andreas* but also Thomas Mann's novel *Der Zauberberg*, a jewel of modern German literature.

GUARDA, Sylvain, Associate Professor, "*Schach von Wuthenow*: Ein Passionsspiel in Fontanescher Manier", *Germanic Review* 68, 2 (10 June 1992), 59-69

This study takes a fresh view of Fontane (1818-1898), seeing him as a card and chess player of utmost subtlety. Not only does it show the ways in which the author expresses his artistic freedom, but it also brings to light Fontane's responsiveness to oriental literary works and the inner complexity of his personality as an artist. His artistic endeavor is

then reinterpreted as a constant coming to terms with an existential dilemma, a process which leads to his characteristic polyperspectivism.

HOFFARTH-ZELLOE, Monika, Assistant Professor, "The Corrective Function of Stereotypes in the Reception of Black American Literature," *Text-Culture-Reception: Cross-Cultural Aspects of English Studies*. Eds. Ahrens, R./H. Antor. Heidelberg: Carl Winter Universitätsverlag, 1992, 569-598.

This article examines the artistic use of racial myths and Black stereotypes in a selective choice of Black American texts. It shows how stereotypes function as frames of cognitive orientation in the reading process. The focus of the study is on Toni Morrison's novels, specifically on her use of clichés and stereotypes with the intent to deconstruct the Western value system. Her characters--black and white--first depict seemingly 'good' and 'evil' figures. A close analysis, however, shows that Morrison's characters are not allegorical types. Instead, they symbolize the paradoxical nature of good and evil. The recognition of the 'evil of the good' and the 'good of the evil' makes the reader examine his own prejudiced world view and leads, eventually, to a reevaluation of his horizon of values.

MYOJIN, Chiyo, Instructor, "Work Ethics and Political Ethics," *Kochi Newspaper*, Japan (March 1992).

This article describes the present economic situation in the United States with regard to present U.S.-Japan relations. It criticizes Japanese politicians' irresponsible statements and attitudes toward the United States and points to the necessity for Japan to rebuild its own chaotic political system prior to questioning the American people's work ethic.

PRUNER, Ludmila A., Associate Professor, Editor, *Working Group on Cinema and Television: USSR and Eastern Europe Newsletter* (WGCTV) 3, 2 (Fall 1991), 1-10.

The WGCTV *Newsletter* is published twice a year by the Working Group on Cinema and Television, a non-profit, non-political society dedicated to the advancement of knowledge, teaching, and research on Soviet and East European cinema and television. The WGCTV is an affiliate of the American Association for the Advancement of Slavic Studies (AAASS) and the Society for Cinema (SCS). The WGCTV *Newsletter* publishes information concerning research, surveys, new film releases, film festivals, joint scholarly projects, and film conferences in the United States and abroad.

During the 1991-1992 academic year, the researcher published Number I of Volume III. The Fall 1991 issue presented information regarding topical events in Russian Soviet society and how the current situation affected cinematic industry in the former Soviet Union.

PRUNER, Ludmila A., Associate Professor, "Editor's Report," *Working Group on Cinema and Television Newsletter* (WGCTV) 3, 2 (Fall 1991), 3.

In this report, the researcher presented a summary

of accomplishments of the Working Group for the past three years, and the role of the Newsletter in the Group's endeavor to promote teaching and research in the area of Russian East European cinema and television. The report listed suggestions for a new editor and results of the poll conducted among the members to change the title of the *WGCTV Newsletter*. The report was followed by an annotated list of conferences on Russian and East European cinema and television in the United States and Europe.



## Presentations

BLEDSON, Penelope M., Associate Professor, "Integrating Interactive Video into the Classroom," Foreign Language Association of Virginia, College of William and Mary, Williamsburg, Virginia, 27 March 1992.

BLEDSON, Penelope M., Associate Professor, "The Use of Spanish-language Press in Teaching Language Skills and Culture," H.B. Woodlawn Alternative School, Arlington, Virginia, 11 October 1991.

BOSSHARD, Marianne, Assistant Professor, Chair, Plenary Session on "Chantal Chawaf," Ninth Annual International Conference on Foreign Literature, Wichita, Kansas, 9-11 April 1992.

BOSSHARD, Marianne, Assistant Professor, "Chantal Chawaf: Jusqu'à l'implosion de la différence," Ninth Annual International Conference on Foreign Literature, Wichita, Kansas, 9-11 April 1992.

CASTRO DE MOUX, María, Assistant Professor, "El entimema en el *Laberinto de Fortuna*: clave para una lectura política," Annual Meeting, American Association of Teachers of Spanish and Portuguese, Chicago, Illinois, 10 August 1991.

CASTRO DE MOUX, María, Assistant Professor, "El escritor, el místico y el loco" (essay) and "A Cirilo se le aparece Jesús" (short story), Congreso Internacional del Texto Místico, Università dell'Aquila, Italia. Sponsored by Tulane University, New Orleans, Louisiana, 24 June 1991.

CASTRO DE MOUX, María, Assistant Professor, "Black Women in Luis Palés Matos' Poetry," Pennsylvania Foreign Language Conference, Duquesne University, Pittsburgh, Pennsylvania, 21 September 1991.

CASTRO DE MOUX, María, Assistant Professor, "Pícaros e Indianos: Tipos de discurso teatral en el *Entremes del Platillo* de Simón Aguado," Golden Age Spanish Drama Symposium. University of Texas, El Paso, Texas, 20 March 1992.

CORREDOR, Eva L., Associate Professor, "The Use of Technology in the Teaching of French Civilization," Ninth International Conference on New Concepts in Higher Education, Technical University of Budapest, Budapest, Hungary, 17-20 June 1991.

CORREDOR, Eva L., Associate Professor, "The Ethics of Expressionism," Sixteenth Annual Colloquium on Literature and Film, devoted to The Context of Modernism 1880-1930, The University of West Virginia, Morgantown, West Virginia, 19-21 September 1991.

CORREDOR, Eva L., Associate Professor, "Minimize Subjective Theory, Maximize Authentic Experience in the Teaching of French Civilization," Conference on Bridging Theory and Practice in the Foreign Language Classroom, Loyola College, Baltimore, Maryland, 18-20 October 1991.

CORREDOR, Eva L., Associate Professor, Session Chair, "Computer Assisted Instruction," Conference on Bridging Theory and Practice in the Foreign Language Classroom, Loyola College, Baltimore, Maryland, 18-20 October 1991.

FLETCHER, William H., Associate Professor, "Multimedia in Foreign Language Education. Planning for the Future," Associated Colleges of the South Symposium "Potential and Perspectives: Modern Technology and Innovative Techniques for Enhancing Language Teaching," Jackson, Mississippi, 20-22 March 1992.

FLETCHER, William H., Associate Professor, "TV or Not TV: These Are the Questions. A Guide to the Video Options for Foreign Language Instruction," Computer Assisted Language Learning and Instruction Consortium, Monterey, California, 27-29 February 1992.

FLETCHER, William H., Associate Professor, "Assessing the Contribution of Authentic Interactive Video to Foreign Language Instruction at the United States Naval Academy," Association for Educational Communications and Technology Conference "Capture the Vision," Washington, DC, 5-9 February 1992.

FLETCHER, William H., Associate Professor, "Integrating Interactive Video into the Foreign Language Curriculum," University of Michigan, Ann Arbor, Michigan, 17 January 1992.

FLETCHER, William H., Associate Professor, and Monika HOFFARTH-ZELLOE, Assistant Professor, "Exploring and Exploiting Authentic German Video: From Comprehension to Commun-



ication," American Council for the Teaching of Foreign Languages Conference, Washington, DC, 23-25 November 1991.

FLETCHER, William H., Associate Professor, "Applications of Authentic Interactive Video to Teaching French, German, and Russian," California State University, San Diego, California, 15 October 1991.

FLETCHER, William H., Associate Professor, "Authentic Interactive Video in the Foreign Language Curriculum," Educational Technology Seminar, U.S. Naval Academy, Annapolis, Maryland, 12-15 August 1991.

GILMORE, Elsa M., Associate Professor, "In the Aftermath of Everything: The Theatre of Marco Antonio de la Parra," Latin American Theatre Today Conference, Lawrence, Kansas, 28 April 1992.

HOFFARTH-ZELLOE, Monika, Assistant Professor, "In Search for Black and Female Equality - Toni Morrison's *Sula*," African Studies Association Conference on "The Questions of Rights," Baltimore, Maryland, 31 October-3 November 1991.

HOFFARTH-ZELLOE, Monika, Assistant Professor, "Exploring and Exploiting Authentic German Video: From Comprehension to Communication," American Council of the Teaching of Foreign Languages-Conference, Washington, DC, 23-25 November 1991.

KNUTSON, Elizabeth, Assistant Professor, "Reading Theory and the Teaching of Literature," Annual Convention of American Association of Teachers of French, Minneapolis, Minnesota, 6 July 1991.

KNUTSON, Elizabeth, Assistant Professor, and Marsha KAPLAN, Foreign Service Institute, "Where is the Text? Discourse Competence and the Foreign Language Textbook," Loyola College Conference, "Bridging Theory and Practice in the Foreign Language Classroom," Baltimore, Maryland, 19 October 1991.

MARQUEZ, Enrique, Assistant Professor, "The Problem of Created Causality in Al-Ghazali and the Medieval Islamic Commentators of Aristotle," National Endowment for the Humanities Research Summer Seminar, Columbia University, Institute of Middle Eastern Studies, New York, New York, 10 June - 17 August 1991.

MARQUEZ, Enrique, Assistant Professor, "Bacon, Montaigne, and the Loss of Analogy's Third Term in Jose Lezama Lima's *Sistema Poético*," Mount Holyoke College, South Hadley, Massachusetts, 10

April 1992.

MARQUEZ, Enrique, Assistant Professor, "Por una causalidad lezamesca," Kentucky Foreign Language Conference, University of Kentucky, Lexington Kentucky, 24 April 1992.

MARQUEZ, Enrique, Assistant Professor, "Plato's *Lysis* and the Concept of Non-objective, Non-possessive Friendship in Lezama Lima," University of Chicago, Chicago, Illinois, 25 April 1992.

MARQUEZ, Enrique, Assistant Professor, "La imagen histórica de José Lezama Lima," Universidad de Caracas, Caracas, Venezuela, 15 May 1992.

MARQUEZ, Enrique, Assistant Professor, "Poetry Reading of Márquez' Own Works," Universidad de Caracas, Caracas, Venezuela, 16 May 1992.

PRUNER, Ludmila A., Associate Professor, "Russian Program at the U.S. Naval Academy," Moscow State University, Moscow, Russia, 22 June 1991.

PRUNER, Ludmila A., Associate Professor, "The New Wave in Kazakh Cinema," 1991 National Convention of the American Association of Teachers of Slavic and East European Languages (AATSEEL), San Francisco, California, 26-30 December 1991.

PRUNER, Ludmila A., Associate Professor, "Russian Video and Television in American Universities," 1991 National Convention of the American Association of Teachers of Slavic and East European Languages (AATSEEL), San Francisco, California, 26-30 December 1991.

PRUNER, Ludmila A., Associate Professor, "Ivan Elagin: Poet and Citizen," 1991 National Convention of the American Association of Teachers of Slavic and East European Languages (AATSEEL), San Francisco, California, 26-30 December 1991.

VOROS, Sharon D., Professor, "Thomas Kyd y Pedro Calderón: la semiótica de la representación femenina," Reunion for Parallel Lives: An Interdisciplinary International Symposium on English and Spanish National Dramas, 1580-1680, Almagro, Spain, 18-21 July 1991.

VOROS, Sharon D., Professor, "Discovering Moorish Women: A Sociosemiotic Approach to Calderón's *Amar después de la muerte*, Part I," Pennsylvania Foreign Language Conference, Duquesne University, Pittsburgh, Pennsylvania, 20-22 September 1991.

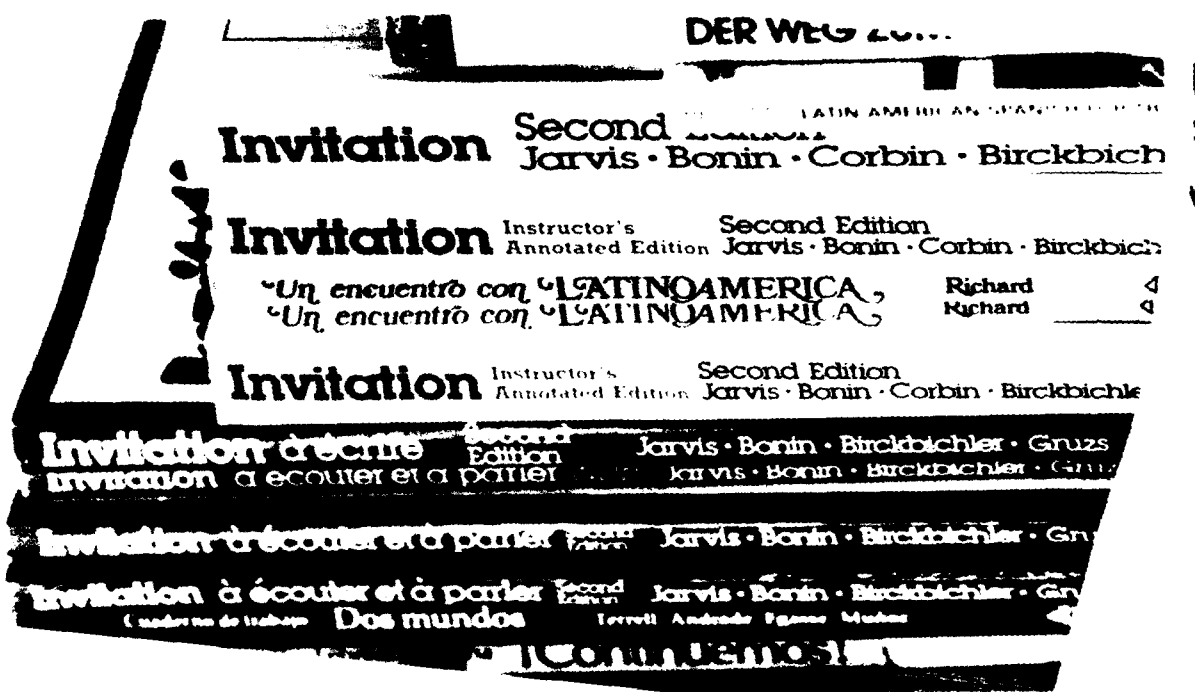
## LANGUAGE STUDIES

VOROS, Sharon D., Professor, "Feminine Symbols of Empire in Thomas Kyd and Pedro Calderón: *The Spanish Tragedy* and *D un castigo, tres venganzas* (By one punishment thrice revenged)," Philological Association of the Pacific Coast, Las Vegas, Nevada, 14-16 November 1991.

VOROS, Sharon D., Professor, "Discovering Moorish Women: A Sociosemiotic Approach to Calderón's *Amar después de la muerte*, *El príncipe constante*, and *El gran príncipe de Fez*, Part II," A

Bilingual Conference on Re/Writing Theater Histories, sponsored by the Organized Research Unit in Hispanic Theater, Department of Spanish and Portuguese, University of California, Irvine, California, 13-15 February 1992.

VOROS, Sharon D., Professor, "Calderón's Writing Women and Women Writers: The Subversion of the *Exempla*," Twelfth Annual International Golden Age Spanish Drama Symposium, University of Texas at El Paso, El Paso, Texas, 18-21 March 1992.





## Political Science

Professor John A. Fitzgerald  
Chair

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**T**he past year has been one of unprecedented dynamic change in the domestic and international political arenas. The Department of Political Science has actively sought to understand and explain the increasingly complicated political complexion of the country and the world through numerous diverse and challenging research projects by both faculty and midshipmen. This vital task helps provide the midshipmen with a sophisticated understanding of both domestic politics and international relations.

Research projects have been conducted on such varied subjects as public policy, German reunification, human rights, United Nations General Assembly roll-call voting, foreign policy rhetoric, Russian-German cooperation, and the Canadian health care system. Sources of funding for this diverse research program included the Naval Academy Research Council, Brown and Benchmark Publishers, the American Bar Association's Commission on College and University Non-professional Legal Studies, the U.S. Army War College, Robert Bosch Foundation/Westview Press, and the Institute for Advanced Study, Princeton University.

The Department of Political Science's active research program has not surprisingly resulted in an impressive array of publications, including several books, chapters for books, and numerous scholarly articles. The faculty has been particularly active in presenting the results of their research in forums ranging from community organization to scholarly and professional meetings in Washington, DC, and throughout the country.

Midshipmen have continued to play a vital role in the department's research program. More than a dozen have completed independent research, and eight have received advanced education awards through the Voluntary Graduate Education Program, the Marine Corps Burke Program, and the Olmsted scholarships.



## **Sponsored Research**

### **Ethics and the Law: Using the Case Method of Instruction**

Researcher: Assistant Professor Priscilla H. Machado  
Sponsor: American Bar Association's Commission on College and  
University Nonprofessional Legal Studies

The purpose of this research is to develop ethics case scenarios and supplemental course materials which recreate a reality and teach midshipmen concepts and theory through specific events. The case method of instruction is highly interactive, helping to develop the student's analytical skills in the face of real world challenges, mostly involving degrees of complexity and uncertainty. These future leaders of the Navy and Marine Corps need to think through these dilemmas in a realistic setting discerning, for example, when to follow orders, and

when to disobey, given the legal and ethical context, ethical choices in a wartime environment, and the legal and ethical responsibilities of officers and of governmental officials. The goal is to create a framework for the presentation of difficult and often sensitive issues in the context of moral and ethical choices. The end product will be shared with other service academies, meeting the overarching goal of ensuring that all young officers understand the ethical and moral responsibilities and burdens that accompany their oath of office.

### **Triggering Exclusion: Understanding the Supreme Court's Fourth Amendment Jurisprudence**

Researcher: Assistant Professor Priscilla H. Machado  
Sponsor: Naval Academy Research Council (OMN)

A common perception in the legal community is that the Supreme Court's search and seizure decisions are inconsistent and generally confusing. Indeed the judiciary has created a maze of standards and exceptions, leaving no "bright line rule" for the police in balancing the rights of accused with the government's need to secure evidence of criminal wrongdoing. It is reasonable to argue the exclusionary rule has been applied haphazardly because of the rhetoric surrounding its use. This debate obscures the essence of the rule's operational validity: whether police misconduct triggers the remedy of exclusion. The research ac-

cesses search and seizure decisions of the United States Supreme Court from 1961 to 1991. The hypothesis is that the Court uses a set of variables to rationalize search and seizure decisions. The key elements of the empirical model are based on the legal notion of police misconduct, level of intrusion, and seriousness of offense. This research is a continuation of a previous NARC grant project. The former produced a lengthy manuscript on the exclusionary remedy and its implications for criminal justice policy. This current research proposes an empirical test of these policy choices.

### **Continuation of Replication of National Norm Studies: U.S. Naval Academy Midshipmen Attitudes and Behaviors**

Researcher: Assistant Professor Eloise F. Malone  
Sponsor: Naval Academy Research Council (OMN)

NARC funding during the 1991 intersessional period allowed study of reactivate midshipmen participation in the American Council on Education (ACE) study of college students. ACE's survey, entitled the "Cooperative Institutional Research Program" (CIRP), represents the largest and longest ongoing

study of the American educational system. The U.S. Naval Academy participated in the study from 1971 to 1986. Last fall, questionnaires were administered to the class of 1995.

The study offers the opportunity to compare midshipmen attitudes and characteristics with national

norms of college freshmen. No particular investigation of a military education context and CIRP responses appears in the literature. Such compar-

isons provide valuable conclusions to students of political socialization patterns, educational trends, and leadership studies.

## **European Security Arrangements and Implications of German Unification**

Researcher: Associate Professor Gale A. Mattox  
Sponsor: Naval Academy Research Council (OMN)

As a result of the dramatic events of 1989 and the revolutions which occurred both in Eastern Europe and later in the Soviet Union, the United States and Western Europe are reassessing the framework for European security established in the post-World War II era. The research examines that framework and the existing institutions which have assured European defense over the past forty-five years. A second step in the analysis is examination of the implications of German unification for European

security. Finally, the security interests and needs of the United States will be considered in light of the substantial changes. The objective of the project will be to define the future interests of Europe, Germany, and the United States and consider the best institutional arrangements to assure future European security. This research was also supported by the German Academic Exchange Service.

## **South East Asian Security: Transition to New Security Challenges and Arrangements**

Researcher: Professor Robert L. Rau  
Sponsor: Naval Academy Research Council (OMN)

The security picture in South East Asia prior to 1992 has been marked by ideological conflict, constant warfare, and the military activities and political and economic interests of the major powers (China, Russia, and the United States). In 1991 the regional powers (Indonesia, Malaysia, Japan, Philippines, Singapore, and India as examples) are assuming greater security and military roles and

postures. As the "old" security threats and issues are slowly resolved (intrafactional warfare in Cambodia; demise of many of the communist party movements) new problems are evolving. This paper analyzes the melding of the old issues with the new actors and forecasts the shape of new security arrangements, as well as the activities of China and Japan in new security roles.

## **The Reagan Administration's Redefinition of Human Rights**

Researcher: Assistant Professor Stephen D. Wrage  
Sponsor: Naval Academy Research Council (OMN)

The research is a study of the reconception of the issue of human rights in American foreign policy carried out in 1981-1982 under the direction of Elliott Abrams, Assistant Secretary of State for Human Rights and Humanitarian Affairs. Working from interviews and documents secured through the Freedom of Information Act, the researcher shows

how the Reagan administration discarded from its agenda of concerns many of the rights most featured by policy makers in the Carter administration, including social and economic rights, and substituted a much narrower list of political and civil rights more central to American political culture.

## Independent Research

### Essays on Aspects of Inter-American Relations

Researcher: Professor G. Pope Atkins

Five essays on various aspects of inter-American relations have been completed, submitted, and copy-edited for inclusion in *The Oxford Companion to Politics of the World*, to be published in 1993 by Oxford University Press (New York). The titles of

the essays are: "Latin American Regional Organizations," "Organization of American States," "Rio Treaty," "Inter-American Development Bank," and "Monroe Doctrine."

### Institutionalization of Hemispheric Free Trade

Researcher: Professor G. Pope Atkins

An article titled "Institutionalization of Hemispheric Free Trade" has been completed and submitted to the editor, to appear in the March 1993 issue of the *Annals of the American Academy of Political and*

*Social Science*. It is an analysis of the possible outcomes of the processes of negotiating free trade areas under the Enterprise for the Americas Initiative.

### Public Policy Research Project

Researchers: Professor Charles L. Cochran and  
Assistant Professor Elosie F. Malone

This project reflects increased interest in public policy which is heightened by a stagnant economy and a government that is increasingly perceived as unresponsive. The research provides an emphasis on the political and economic aspects of policy. It involves substantive comparative policy analysis with other countries, especially Canada, Japan, and Western European nations. Research includes study of housing, education, health care, and the environment against the backdrop of policy goals,

ethics, economics, and political systems.

Stress is placed on the economic basis of public policy, discussing the difference between public and private goods, the problems of scarcity and rational self-interest. Public policy is defined, and a typology of policy is discussed. Finally, an examination is made of public choice theory which is making an impact upon public policy research studies with the profession.

### The Congressional Game

Researcher: Professor Stephen E. Frantzich

A number of different perspectives can be used to analyze the U.S. Congress. The game analogy invites the observer to focus attention on the players, rules, strategies, and the winners and losers. This research involves developing a game-based approach searchable database. Over 400 quotes from over 100

sources have been entered. The database is serving as the basis for a book on the Congress which has been accepted for publication by Brown and Benchmark Publishers and will be co-authored by Steven Schier of Carleton College. The first four chapters have been written.

## **The Game of American Politics**

Researcher: Professor Stephen E. Frantzich

This major (640 pages) textbook on American politics and government is currently undergoing its final round of substantive reviews and will be published in 1993 by Brown and Benchmark Publishers. It uses a game analogy to describe the political process and pays special attention to the

ways in which new communications technologies have altered the playing field. The text, co-authored by Stephen Percy, will be supplemented with a two-hour video tape (currently in production), a faculty guide, and a study guide (in first draft form).

## **Reasonable Disagreement: Two Senators and the American Political Dilemma**

Researcher: Professor Karl A. Lamb

Eight out of a planned twelve chapters were completed during this period. On completion, planned

for 20 August 1992, the manuscript will be about 300 pages.

## **The Design and Redesign of the Rule of Exclusion: Search and Seizure Law in the United States and Canada**

Researcher: Assistant Professor Priscilla H. Machado

Balancing the rights of accused with government's concern for security and the rights of society is a timeless challenge which all democratic nations face. Using Herbert Packer's models of the criminal justice process, this project compares the changes in search and seizure law which have occurred in the United States and Canada. The issue of what to do with evidence tainted by an illegal search and sei-

zure clearly illustrates the tradeoffs countries are willing to make concerning citizen-police encounters. The alternations noted constitute more than a shift in policy; they reveal changes in the basic premises of the respective criminal justice systems. This research is currently being reviewed for publication by the *Canadian American Bar Review*.

## **Forget the Rhetoric: What the Fourth Amendment Really Means**

Researcher: Assistant Professor Priscilla H. Machado

After analyzing the history of exclusionary rule adjudication, this paper presents an alternative way of understanding the exclusionary rule in the future. Considering the Supreme Court's exclusionary rule cases and focusing particularly on the last decade,

the researcher concludes that the remedy to prevent unreasonable searches and seizures may lie in an approach other than exclusion. This study is a part of a larger work on the Fourth Amendment and the exclusionary rule.

## **Quebec Independence Movement**

Researcher: Assistant Professor Eloise F. Malone

This research has culminated in a proposal submitted for a presentation in November 1992 to The American Council for Quebec Studies Biennial Conference. As the fall referendum for Quebec

sovereignty approaches, interest grows in the United States' policy position. With the exception of a statement made by President Bush during a 1991 visit to Ottawa, no official reaction has been voiced.



Pundits of U.S.-Canadian relations argue the "two-track" policy will continue. Essentially, this policy position insists that Quebec sovereignty is a Canadian issue, but that the United States maintains a vested interest in a united Canada.

The researcher proposes a systematic investigation of the U.S. policy position regarding Quebec

independence. Using official documents and scholarly sources, the study will cover the period since the rebirth of Quebec nationalism in the 1960's. From 1980 to the present, little written or stated policy exists. This research will include interviews with U.S. government officials and business representatives to determine possible U.S. reaction.

## **The European Community and Eastern Europe: Prospects for Democracy**

Researcher: Associate Professor Gale A. Mattox

The fall of the Soviet Union has left Eastern Europe in shambles. Although the newly-elected governments of the region have tried to move toward liberal democracy, there have been substantial political and economic hindrances to their efforts. The years of state planning ruined the infrastructure of Hungary, Poland, Czechoslovakia, Romania, and Bulgaria. The underlying assumption of this study is that economic development must occur in order to establish and maintain stable democracies in those countries.

After a brief history of the economic development

of Europe in both the East and West, the revolutions of each country are considered and solutions to the problems of Eastern Europe are suggested, particularly with respect to aid from the European Community (EC). The conclusion reached based on the research is that the EC is in a good position to aid Eastern Europe, but there are various factors that will hinder EC efforts to assist. Ultimately, however, the EC will want to integrate these East European emerging democracies into the Community.

## **Analysis of the Mainland Chinese Leadership**

Researcher: Professor Rodney G. Tomlinson

The Chinese Leadership project is now in its sixteenth year. With the addition of 100 new biographies and near completion of a thorough review, the information should be very current. The trend towards liberalization noted last year has ceased with the removal of some progressives. However, the fact that many of the conservatives

have grown only older suggests that change is not far away. Even younger conservatives appear willing to compromise, thereby heralding a subtle move towards greater liberalization. This project continues the research of Professor Emeritus Daniel T.Y. Lee, who collaborates in this work.

## **Editing the Private Letters of Charles H. Fowler**

Researcher: Professor Rodney G. Tomlinson

Charles H. Fowler served in Theodore Roosevelt's Navy from 1906-1910. Joining in 1906 as a seamen recruit, young Charles' skill with the pen and word led to his near immediate assignment as a ship's log writer. Assigned to the U.S. Asiatic Squadron at Subic Bay, Philippine Islands, Fowler's bright mind and attention to detail attracted his superiors' atten-

tion, and lead to his participation in many interesting exercises and activities of the day. Fowler chronicles life in the Orient through a collection of eighty letters to his sister, along with over 200 photographs. Fowler provides first hand look at life 'tween' decks in an articulate and engaging style rarely found among enlisted men.

## **Issues and Alignments in the United Nations--Two Decades of Change**

Researcher: Professor Rodney G. Tomlinson

This research examines the issues and alignments in the United Nations from the thirtieth General Assembly (1975) to the present forty-sixth (1992). It examines issues, their saliency, and the alignment

shifts through time. Principal collaborator in this effort is Professor Steven Holloway, St. Francis Xavier University, Antigonish, Nova Scotia.

## **The Structure of International Events--Testing a Theoretic Model of World Political Behavior**

Researcher: Professor Rodney G. Tomlinson

Rules and norms circumscribe international political behavior. The vast majority of national leaders conform to customs of diplomatic practice. They tend to ascribe to similar perceptual constructs as to the meaning and impact of certain actions. This case study and analysis effort identified patterns of conduct indicative of stable, problem-solving relationships and found evidence to characterize

non-problem solving behavior. The presence or absence of the patterns provides clues to the general outcome of a situational issue. These findings independently corroborate work of other scholars, thereby lending credence to some general theories of conflict. The results of this research may be reported in a paper at the International Studies Association Annual Meeting in March 1993.

## **Saddam Hussein and the Problem of Justifiable Assassination**

Researcher: Assistant Professor Stephen D. Wrage

The research will lead to a case study to be presented at a conference entitled "The Ethics of War and Peace" to be held 4-7 January 1993 in Jerusalem. The case will examine the issues raised by attempts to target Saddam Hussein and will

judge these in the light of the history of attempts against heads of state in wartime. This research was supported by the Institute for Advanced Study at Princeton University.

## Research Course Projects

### Educational Policy: U.S. and Japan

Researcher: Midshipman 1/C Jonathan Barney, USN  
Adviser: Assistant Professor Eloise F. Malone

Education reform is currently a "hot" topic in Washington. President Bush has initiated six education goals to be met by the year 2000. Education Secretary Lamar Alexander recently appeared on the cover of *Time* magazine saying how he will get the U.S. "back on track." Americans have placed education as one of the most important issues facing the nation today. The reason for this focus is that American students seem to be lagging far behind their counterparts in other nations. Many

different reasons for the decline have been proposed. This research systematically evaluated the decline in American education through a comparative analysis with the Japanese educational system. Specifically, it addressed the research question, "Do curriculum differences between Japanese and American schools account for the performance differences between Japanese and American school children?"

### Democracy in Asia

Researcher: Midshipman 1/C Erik P. Bethel, USN  
Adviser: Professor Robert L. Rau

This project is an analysis of the specific nature of democracy in selected Asian countries (Japan, China, Malaysia, and Singapore among others). A paper was written for presentation at the 1992 Naval

Academy Foreign Affairs Conference. In that study, the researcher concludes that although democratic practices may not have an American origin, they are effective and appropriate for most countries studied.

### Quality of Life in Cuba

Researcher: Midshipman 1/C Erik P. Bethel, USN  
Adviser: Associate Professor Barbara Harff

This paper is an analysis of the post-revolutionary "Quality of Life" in Cuba. It means to answer the following research questions: (1) How has the "Quality of Life" changed since 1959-1960? (2) What factors have led to this change? (3) What effect has

the Castro regime had on the "Quality of Life?" and (4) What is the relationship between the "Quality of Life" and the social, economic, and political variables defined in the theoretical model?

### Reunification: Successes and Failures

Researcher: Midshipman 1/C Don E. Ceramic, USN  
Adviser: Professor Arthur R. Rachwald

This work involved a comprehensive survey of domestic and international impact of German unification. It examined sources of a traditional and deep mistrust of a dominating and possible revanchist Germany, German security issues in the framework of NATO, CSCE, bilateral U.S.-German

and French-German relations, and the Polish-German border issues, as well as political and economic developments in Germany after unification. It concluded that the new state is not a Fourth Reich, but the future profile of Germany continues to be ambiguous.

## **An Analysis of the Canadian Health Care System**

Researcher: Midshipman 1/C Shaun C. Francis, USN  
Adviser: Professor Charles L. Cochran

This is an analysis of the evolution of the Canadian health care system, which provides that a citizen of Canada will not be denied health care because of financial barriers or any other factors. The evolution of this system has produced some funda-

mental problems. Funding, accessibility, and human resources are the main areas of concern in the present system. The paper analyzes the rising costs of the health care system, attributes possible causes, and discusses possible solutions.

## **Foreign Policy Rhetoric of the Bush Administration during the Persian Gulf Crisis**

Researcher: Midshipman 1/C Shaun C. Francis, USN  
Adviser: Professor Helen E. Purkitt

The initial hypothesis of this study was that the key Bush administration actors framed their perceptions of the problem and possible solution in the Persian Gulf foreign policy crisis in terms of a limited number of analytical dimensions. This thesis is based on past research which indicates that people generally only use a few analytical dimensions to understand problems, to make decisions, and to justify specific actions taken.

During the Cold War officials typically used a few key ideas related to such central organizing principles as the need to contain communism. The end of the Cold War eliminated a shared sense of U.S. interests and the rationale for U.S. foreign policy action. There have been numerous attempts to describe the key ideas underlying foreign policy during the Bush administration, with such overarching concepts as the 'New World Order' used by Bush officials. However, there is still no agreement on the meaning of this term or whether it will provide the organizing concept to justify U.S. foreign policy in the post-Cold War environment. This study was an attempt to systematically describe the underlying problem solving logic used by the Bush administration to understand the problem con-

fronting the United States when Saddam Hussein invaded Kuwait and to justify subsequent U.S. actions.

The result of the research clearly indicates that the overwhelming majority of themes coded from the rhetoric can be categorized as 'counter aggression.' The problem-solving logic which guided the framing of the problem to the public and subsequent U.S. actions are grounded within this analytical dimension. This problem-solving logic evidenced a simple structuring which remained consistent over time, and that in each sample of rhetoric there are at most two to five themes present which tend to be dependent on the situation and task at hand.

These results indicate that policy makers are limited information processors who are able to frame a problem or situation using only one or two major analytical dimensions. Because of this limitation in information processing, policy makers will consistently frame the problem with this problem-solving logic, which in turn limits the different ways the problem and subsequent U.S. action will be presented in their public rhetoric.

## **U.S. Counternarcotics Policy in the Andean Region: International Legal Basis, Limitation, and Consequences**

Researcher: Midshipman 1/C J. Kevin Ellzey, USN  
Adviser: Professor G. Pope Atkins

The U.S. government, led by the Department of State, Department of Defense, and the Drug Enforcement Agency, has targeted the Andean states of Columbia, Peru, and Bolivia as the key actors in the international narcotics traffic, particularly in cocaine. A broad array of counternarcotics actions has resulted, leading to both cooperation and friction with the Andean

nations. This paper analyzes legal aspects of U.S. counternarcotics policies in the Andean region: the international legal basis for policies and interactions, the limitations they place on U.S. action, and the degree to which they retard U.S. unilateralism and encourage bilateralism or multilateralism in the "war on drugs."

## **A Hierarchy of Law and Natural Law's Place and Role in Jurisprudence**

Researcher: Midshipman 1/C Scott C. Hottenstein, USN  
Adviser: Assistant Professor Priscilla H. Machado

This project sets up a hierarchy of law, and then puts natural law in a definite position in order to determine its place in jurisprudence. The researcher looks at definitions of law and rights and what makes them natural as opposed to man made.

Based on these definitions, categories of conflict between different types of law will be established and resolved, leading to conclusions concerning natural law's place and role in jurisprudence.

## **United States Step Toward Democracy**

Researcher: Midshipman 2/C Sean G. Kelliher, USN  
Adviser: Professor Arthur R. Rachwald

The international dilemma presently confronting the United States is one of rapid democratic changes among many countries of the world. America's foreign policy objectives must be directed toward assisting these transitional countries in order to ensure their success. This study evaluates arguments on behalf of an international organization with the goal of promoting and coordinating support for de-

mocracy. Such an institution would best accomplish its objectives through the creation of two distinct bodies: one representing national governments and the other representing ethnic groups. The Conference of the Security and Cooperation in Europe could serve as an example and pattern of an institutional arrangement promoting a worldwide democratization.

## **Individualism versus Collectivism in the Perspective of Selected Thinkers**

Researcher: Midshipman 1/C Karl W. Riebs, USN

Adviser: Professor Arthur R. Rachwald

Politicians and philosophers have, since before the days of Plato, wrestled with the question of the proper and ideal relationship between man and his society. This work discussed this relationship as presented by several thinkers from ancient times to the era of modern American constitutionalism. Its main thesis assumed that in the center of Western political thought is a concept of "inalienable rights."

This idea maintains a balance between individualism and collectivism by placing the individual forever beyond the reach of government of the majority. This arrangement in case of the American democracy can make meaningful sense only in light of the experience and perspective of the great political thinkers who gave primacy to individual rights over the collective craving for order.

## **Unholy Alliance: The Evolution of Russian-German Cooperation, 1917-1922**

Researcher: Midshipman 2/C Jeffrey J. Truitt, USN

Adviser: Professor Arthur R. Rachwald

This research project examined the 1922 Russian-German treaty and its significance for the Russian-German relations today. In 1922 the Russian leaders betrayed their ideology and opportunity to establish profitable economic relations with the West in order to secure their place in global power structure and to fortify their position at home. This

"ends justifies the means" approach to international affairs has long tradition in both German and Russian history, and the neues Rapallo alternative continues to be a viable option for Berlin and Moscow in the post-Cold War politics, especially if the United States continues to decline as a global power.



## Publications

ATKINS, G. Pope, Professor, "Latin America's International Relations in the Post-Cold War Era," *World Politics* 92/93. Thirteenth Edition; Guilford, Connecticut: Dushkin Publishing Group, 1992.

As the United States abandons its 180-year-old preoccupation with minimizing what it saw as hostile foreign intrusions in the Western Hemisphere, other regional, subregional, and national issues have risen to the top of everyone's agenda. In such an environment, the United States cannot expect Latin America to be its exclusive preserve, even with a hemispheric free trade agreement. In the future, Latin Americans will insist on maintaining and expanding further their broad array of external relationships.

ATKINS, G. Pope, Professor, ed., *The United States and Latin America: Redefining U.S. Purposes in the Post-Cold War Era*. Austin: Lyndon B. Johnson School of Public Affairs, University of Texas at Austin, 1992.

The end of the Cold War has presented new challenges to policy makers in the United States as they attempt to redefine their Latin American relationships in the context of a new international era. Under Professor Atkin's editorship, fourteen experts explore the political, economic, military, sociological, and human rights dimensions of U.S. policy in inter-American relations and assess the prospects for hemispheric cooperation and unity.

FRANTZICH, Stephen E., Professor, *Storming Washington: An Intern's Guide to National Government*. Washington DC: American Political Science Association, 1991 (Third Edition).

A comprehensive guide to securing and participating in Washington, DC, internships. The guide includes both helpful hints and the most extensive directory of formal academic programs currently available.

FRANTZICH, Stephen E., Professor, *Using C-SPAN in the Classroom: A Faculty Guide*. West Lafayette, Indiana: Purdue University, 1991 (Second Edition).

A "hands on" teachers' guide to integrating public affairs programming into political science, communications, and journalism courses. This guide serves as the text for the C-SPAN seminar for professors offered three times per year.

FRANTZICH, Stephen E., Professor, *Government*

*Service Delivery in a Technological Age: Path to Innovation*, Washington DC: U.S. Congress Office of Technology Assessment, November 1991.

An extensive analysis of the theoretical literature on technological innovation with particular emphasis on its applicability in the public sector.

FRANTZICH, Stephen E., Professor, *Technological Innovation in European Government Service Delivery: Selected Case Studies*, Washington, DC: U.S. Congress Office of Technology Assessment, November 1991.

A comparison of technological innovations in government service delivery in seven countries with the description of projects and contact numbers.

FRANTZICH, Stephen E., Professor, *Technological Innovation in Federal Government Service Delivery: Selected Case Studies*, Washington, DC: U.S. Congress Office of Technology Assessment, November 1991.

Case studies of successful federal government use of information technology to provide enhanced public service, with an attempt to identify strategies and approaches that could be used in other agencies.

HARFF, Barbara, Associate Professor, "Cambodia: Revolution, Genocide, Intervention," Jack A. Goldstone, Ted R. Gurr, and Farrokh Moshiri (eds.) *Revolutions of the Late Twentieth Century*. Boulder: Westview Press, 1991, pp. 218-234.

This chapter identifies the principal factors leading to the revolutionary victory of the Khmer Rouge in 1975. Goldstone posits these factors as "declining state resources relative to expenses and the resources of adversaries, increasing elite alienation and disunity growing popular grievances and autonomy." The Cambodian case does not fit neatly Goldstone's model. The state did not suffer fiscal distress; rather, the Vietnam War had dire consequences for Cambodia, and Khmer Rouge ideology attracted support from peasants who then unleashed the fury against urbanites.

HARFF, Barbara, Associate Professor, "Recognizing Genocides and Politicides," Helen Fein, ed., *Genocide Watch*. New Haven: Yale University Press, 1992, pp. 27-41.

This chapter delineates and argues for a more restrictive use of the terms "genocide" and "politi-

cide." By the author's definition genocides and politicides are the promotion and execution of policies, by a state or its agents, which result in the deaths of a substantial portion of a group. The chapter then examines how to detect geno/politicides and identifies means by which they are implemented.

HARFF, Barbara, Associate Professor, co-author, "The Rights of Collectivities: Principles and Procedures in Measuring Human Rights Status of Communal and Political Groups," Thomas B. Jabine and Richard P. Claude, eds. *Human Rights and Statistics: Getting the Record Straight*. Philadelphia: University of Pennsylvania Press, 1992, pp. 159-187.

This work is an epistemological and methodological account of the authors' research in developing comparative data at the group level of analysis. The first author discusses the criteria used in identifying and coding 44 episodes of geno/politicides since World War II, episodes in which ruling groups as a matter of policy killed many members of target groups. The reliability and validity of codings of group data on human rights and their violations are assessed. The second author focuses on communal groups that are differentially treated as a matter of social practice and/or public policy and describes a study of some 230 groups in 126 countries that meet the criteria.

MALONE, Eloise F., Assistant Professor, and Charles L. COCHRAN, Professor, "Relationship Between Individual and Organizational Ethics in the Military: Efforts to Develop Ethical Perspectives in the Officer Corps," *Proceedings of the National Conference on Ethics*. California State University: 1992, pp. 53-58.

Congressional recommendation resulted in "ethics" topics being introduced into Naval Academy curriculum. Teaching ethics in a military environment highlights contradictions between the chain of command and obedience to the law. The goal of such instruction is to promote awareness and sensitivity to ethical concerns and thus to serve the Navy's mission.

MACHADO, Priscilla H., Assistant Professor, co-author, "Postindustrialism and the Changing Face of Administrative Litigation in England, 1960-1985," *Social Science Journal*, 29, 2 (April 1992), 185-198.

This article seeks to answer two questions: (1) how exactly has the political role of administrative law changed since 1960, and (2) can these changes be attributed to postindustrialism? A sample of Queen's Bench and Chancery Division cases of the High Court from a five-year interval suggests that there has been no quantitative increase in

administrative law cases, either absolutely or as a percentage of all cases decided. There has been, however, a decided shift in subject matter from economic cases to non-economic ones, as well as a change in the types of parties bringing cases. Despite these changes it does not appear that the postindustrial model has much convincing explanatory power. Instead, the institutional evolution thesis seems better to fit the findings.

MATTOX, Gale A., Associate Professor, co-author, *Germany at the Crossroads: Foreign and Domestic Policy Issues*, Boulder, Westview Press, 1992.

The incorporation of the German Democratic Republic into the Federal Republic ignited excitement over the prospect of bringing democratic reform and better living conditions to the East but also gave rise to concern over the ability of Germany to do so while maintaining its own economic vitality. The volume examines many of the issues integral to the tremendous changes--in foreign and security policy, politics, economics and technologies and public policy--that Germany confronted even before unification and will continue to confront with unification in the future. *Germany at the Crossroads* is an edited book with chapters selected by the editors and a review board. It attempts to provide an overview by U.S. experts of a wide range of issues confronting Germany today.

PURKITT, Helen E., Professor, editor, *Annual Editions, World Politics 1992/3*, Sluice Dock, Connecticut: Dushkin Press, 1992.

This book is a collection of 45 articles about recent issues and trends in international affairs. The book is organized into eight sections covering major current issues in each regional subsystem of the world and key policy issue areas related to the global economy. The volume is designed to be used as a supplementary text in introductory courses in International Relations, U.S. foreign policy, and national security issues.

PURKITT, Helen E., Professor, "Policy-Making in the Context of Small Groups: The Cuban Missile Crisis Revisited - One More Time," E. Singer and V. Hudson, eds., *Political Psychology and Foreign Policy*. Boulder, Colorado: Westview Press, 1992.

This chapter uses an information based perspective of political decision making and the original transcripts from deliberation of the executive committee group advising President Kennedy during the Cuban Missile Crisis to examine the more general theoretical implications of this famous Cold War crisis. Little evidence was found to support the proposition that foreign policy decision making under crisis conditions represents a distinct type of



political decision making. Instead, U.S. decision makers during the Cuban Missile Crisis used a "satisfying heuristic" which was similar to the administrative decisions in both the 'real world' and experimental contexts. This study thus supports a growing body of research which suggests that intuitive choosers generally use a very simple problem solving logic and fail to use all relevant information to understand and then solve complex and uncertain political problems.

TOMLINSON, Rodney G., Professor, "Monitoring WEIS Events Data in Three Dimensions," Richard L. Merritt, et al, *Management of International Events: DDIR Phase II*. Urbana, Illinois: University of Illinois Press, 1991, Chapter 4.

In 1972 the WEIS project developed metric scales for the twenty-two combined event categories of international behavior. In 1977 a final set of values was determined, using professional diplomats for judges. Additionally, exponential smoothing looked very promising as the basic computational model for event monitoring. The techniques are re-introduced and their use illustrated using behavior pairs for the USA-USSR, USA-United Kingdom, and USSR-Czechoslovakia. The two-dimensional composite "constructive - deconstructive" scale is introduced. The gaps between the actors' plot lines appear as related concepts of reciprocity. The notion of "response-demand" is suggested. A three-dimen-

sional behavior model is shown using moral and power as underlying concepts with time as the third axis. The moral and power constructs are shown to be inversely related. Stable relationships appear to have events GRANT, REWARD, PROPOSE, and AGREE regularly mingled among more assertive event types. Additional directions for research are proposed, and the work of two scholars pursuing related objectives is cited and the connections noted.

TOMLINSON, Rodney G., Professor, *Reference Guide to the 46th (1991) United Nations General Assembly Rollcalls*. Washington, DC: United States Department of State, March 1992.

This is a reference document that summarizes voting records of the members of the United Nations for the Forty-Sixth (1991) General Assembly. All rollcalls are studied and cataloged according to agenda, date, location, major and minor subjects, and important related incidents and issues in world affairs. A short descriptive passage is prepared, and rollcall votes for each member are appended. A series of cross-reference indexes are prepared to provide quick look by dates, resolution number, agenda number, location, and topical keywords. This document is published for use by members of the U.S. Diplomatic Corps and U.S. missions abroad to facilitate research into positions taken by the nations to which they are accredited.

## Presentations

ATKINS, G. Pope, Professor, "Changing Latin American International Relations: Implication for U.S. Policy," U.S. Army John F. Kennedy Special Warfare Center and School, Fort Bragg, North Carolina, 24 April 1992.

ATKINS, G. Pope, Professor, "Cold War and Post-Cold War Developments in Latin America," panel moderator and commentator, Annual Meeting, Middle Atlantic Council of Latin American Studies, College Park, Maryland, 4 April 1992.

MALONE, Eloise F., Assistant Professor, "Canada: The Independence Movement and Internal Security," Annual Meeting of the American Political Science Association, Washington DC, 31 August 1991.

FRANTZICH, Stephen E., Professor, "The American Political System," Briefings for Taiwanese and Korean Legislators, George Washington University, Washington, DC, 16 October 1991, 15 May 1992.

FRANTZICH, Stephen E., Professor, "The Constitution in a Technological Age," Constitution Day Assembly, Broadneck High School, Arnold, Maryland, 18 November 1991.

FRANTZICH, Stephen E., Professor, "Politics and Technology in a Cynical Age," Phi Beta Kappa Lecture, Hamline University, St. Paul, Minnesota, 17 May 1992.

FRANTZICH, Stephen E., Professor, "POLIWARE Computer Software: Strategies for Development and Methods of Classroom Application," one day faculty short course at the American Political Science Association Convention, Washington, DC, 31 August 1991.

FRANTZICH, Stephen E., Professor, "Technology and the Constitution," Anne Arundel County Gifted and Talented Teacher's Seminar, Annapolis, Maryland, 9 July 1991.

FRANTZICH, Stephen E., Professor, "The Technological Threat to the Constitution," Maryland State Convention of Social Studies Teachers, Annapolis, Maryland, 17 October 1991.

FRANTZICH, Stephen E., Professor, "Using C-Span in the Classroom," C-SPAN Seminar for Pro-

fessors, Washington, DC, 7-8 January, 10-11 June, and 12-23 August 1991; 8-9 June 1992

MACHADO, Priscilla H., Assistant Professor, "Institutional Practices In and Around the Supreme Court," panel chair, American Political Science Association, Washington, DC, 31 August 1991.

MACHADO, Priscilla H., Assistant Professor, "If Politics is a Dirty Business ... Do We Get What We Deserve?" Pi Sigma Alpha Awards Banquet, Lycoming College, Williamsport, Pennsylvania, 6 April 1992.

MATTOX, Gale A., Associate Professor, "Challenges to International Security," Washington Center, U.S. Department of Labor, Washington, DC, 9 August 1991 (Carried on C-SPAN).

MATTOX, Gale A., Associate Professor, "Domestic Links to German Foreign Policy," Center for International Security Studies Conference, University of Maryland, College Park, Maryland, 24 April 1992.

MATTOX, Gale A., Associate Professor, "The German Role in Emerging European Security Arrangements," American Institute for Contemporary German Studies, Washington, DC, 5 November 1991.

MATTOX, Gale A., Associate Professor, "New Directions for International Security," Women in International Security Summer Symposium, St. Mary's College, St. Mary's, Maryland, 28 June 1991.

MATTOX, Gale A., Associate Professor, Opening Address, Washington Center Summer Symposium Global Village, "The United States and the New World Order," Trinity College, Washington, DC, 18 May 1992.

PURKITT, Helen E., Professor, "Regional Security Issues: Africa," Second Annual Conference for Young Women (and Men) Interested in Careers in International Security sponsored by Women in International Security (WISS), St. Mary's College, St. Mary's, Maryland, 30 June 1991.

PURKITT, Helen E., Professor, "Evaluation of the Annapolis Interactive Video Project: 1987-1990," AECT Conference, Washington DC, 7 February 1992.

## POLITICAL SCIENCE

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PURKITT, Helen E., Professor, "The Impact of Using Explicit Decision Aids on Intuitive Analyses of International Conflicts: An Information Processing Perspective," American Political Science Association, Washington, DC, 31 August 1991.

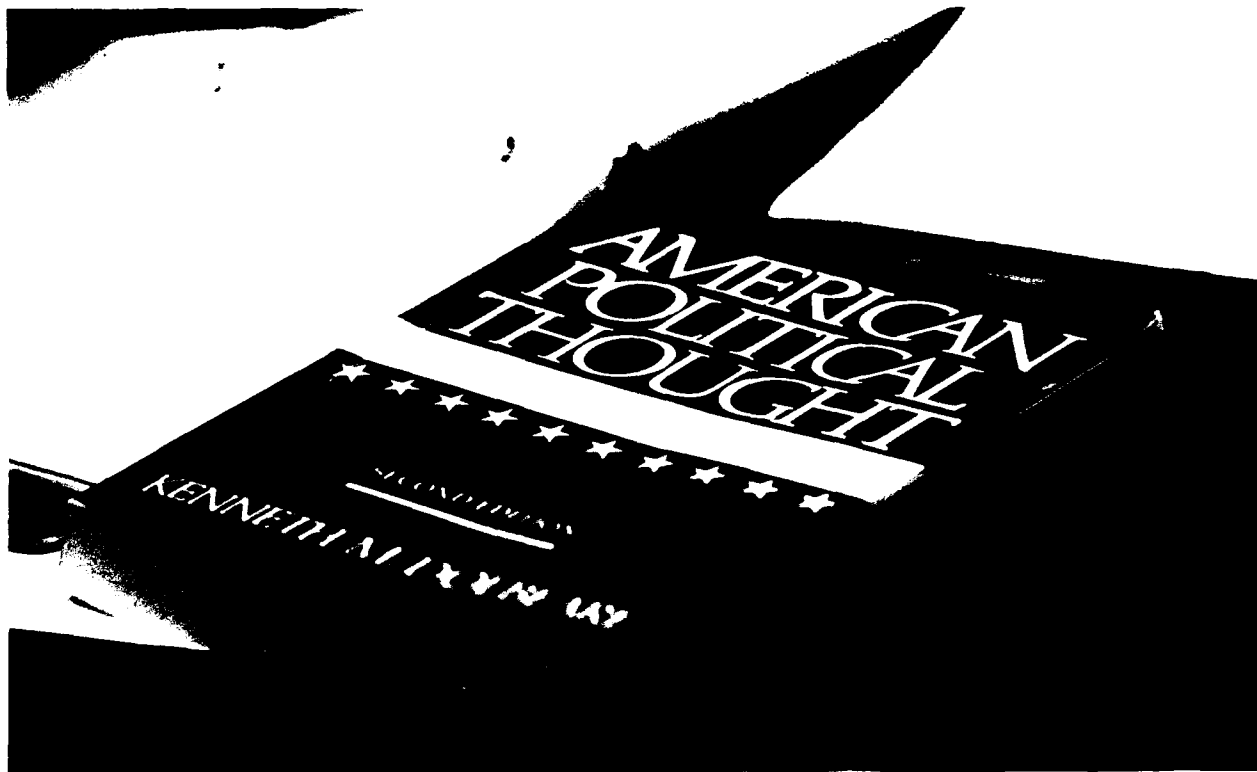
WRAGE, Stephen D., Assistant Professor, "Carter and Ideological Leadership: The Case of Human Rights," Annual Meeting, American Political Science Association, Washington, DC, 30 August 1991. [presentation was televised on C-SPAN]

WRAGE, Stephen D., Assistant Professor, "Ethics and Orders: A Case Study in Ethics and Command" Carnegie Council Teaching Institute, Athens, Georgia, 24 February 1992.

WRAGE, Stephen D., Assistant Professor, "Human Rights and Arms Transfers" International Studies Association, Strategic Studies Meeting, Annapolis, Maryland, 7 November 1991.

WRAGE, Stephen D., Assistant Professor, "Presidential Leadership and Political Myth: The Case of Lincoln in the Civil War," International Studies Association, Vancouver, British Columbia, Canada, 21 March 1991.


WRAGE, Stephen D., Assistant Professor, "Teaching Ethics by the Case Study Method," Annual Convention, International Studies Association, Atlanta, Georgia, 3 April 1992.



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## Division of Mathematics and Science





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**KING LEAR** *William Shakespeare*

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# Chemistry

Professor Mark L. Elert  
Chair

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**T**his year marked the completion of the Chemistry Department's new x-ray diffraction laboratory. This facility is already used heavily by both faculty and students; the lab complements existing instruments by providing a means to identify the molecular structure of crystalline substances. The department now has a wide range of state-of-the-art instrumentation which allows the faculty to be competitive in research in all of the traditional branches of chemistry.

The Chemistry Department faculty continues active in their research interests. The young and energetic scholars have initiated research programs which are increasingly productive, and which complement and broaden the research interests of the more senior faculty. Student interest and involvement in research have increased correspondingly, as evidenced by the two Trident Scholars who completed projects in the department this year. Two more Trident Scholars in chemistry have been selected for next year, and several other student research projects are planned or underway.

The Chemistry Department has a long tradition of collaborative research efforts with Navy laboratories and other private and government institutions. This year collaborative projects are underway with the Naval Research Laboratory, the Naval Surface Warfare Center, the Naval Medical Research Institute, and the National Aeronautics and Space Administration. Other faculty members have obtained external grant support from the National Science Foundation, the Army Research Office, and the Petroleum Research Fund.



Research interests of the faculty range from fundamental studies of molecular structure and dynamics to practical investigations of chemical problems in forensics, corrosion, and hazardous material handling. This wide range of research activity helps to strengthen and invigorate the chemistry curriculum of the Naval Academy, preparing our graduates for the technical challenges they will encounter in the Fleet.

## Sponsored Research

### Quartz Crystal Microbalance Study of Mercury Deposition onto Platinum

Researcher: Associate Professor Graham T. Cheek

Sponsor: Naval Research Laboratory, Code 6171

Investigations of mercury deposition are being carried out in order to determine the extent of amalgamation with the deposited platinum substrate. It is planned to use these mercury films for spectroscopic studies and for investigations of interactions of electrogenerated hydrocarbon radicals with the mercury surface. These studies have been carried out on 5 MHz AT-cut quartz crystals with vapor-deposited platinum electrodes. Initial work has involved mercury deposition onto platinum from 1 mM mercuric nitrate/0.1 M perchloric acid solution. As the potential was scanned (10 mV/s) into the region for bulk mercury deposition (+0.35 V vs SCE), a decrease in frequency (-100/-300 Hz), corresponding to an increase in mass, was observed. Following scan reversal at +0.20 V, the stripping process at +0.40 V was accompanied by a frequency increase to

nearly the initial value. Holding the potential at +0.80 V for 5 minutes usually brought the frequency value to within 2-3 Hz of the initial value. These results indicate that deposited mercury does not extensively form an amalgam with the platinum substrate under these conditions. A very small anodic process at +0.55 V, corresponding to amalgam oxidation, was seen following the larger stripping peak at +0.40 V, and confirms that amalgam formation is slight. Allowing the potential to reach 0.00 V during deposition, however, results in a permanent frequency decrease of approximately -100 Hz, even after holding at +0.80 V. It was found that removal of somewhat more mercury was possible by holding the potential at +1.20 V. Further work in this area is planned for other metals, particularly silver, which is known to act as a suitable substrate for mercury electrodes.

### Studies of Reactive Molecular Fragments by Matrix Isolation Spectroscopy

Researcher: Associate Professor Robert F. Ferrante

Sponsor: Naval Academy Research Council (ONR)

The purpose of this project is to prepare, identify, and spectroscopically characterize highly reactive chemical intermediates using the matrix-isolation technique. This part of the study has focused on the radical acetylnitrene,  $\text{CH}_3\text{CON}$ , one of the simplest carbonylnitrenes. Early mechanistic proposals regarding the well-known Curtius rearrangement centered on the carbonylnitrenes ( $\text{R-CON}$ ). However, there was little chemical evidence, and virtually no spectroscopic proof of the existence of these species.

In this study, evidence for the trapping of acetylnitrene has been obtained. These features were produced when the parent acetyl azide was subjected to metastable energy transfer (MET) fragmentation by interaction with excited  $\text{N}_2$  produced in a microwave discharge. This MET method has been shown to favor production of triplet state nitrenes in related azide systems. New signals attributable to  $\text{CH}_3\text{CON}$  include a weak

ESR line near 8200 G, characteristic of a triplet molecule with  $D = 1.6 \text{ cm}^{-1}$ , and IR bands near 1770, 1380, and  $1350 \text{ cm}^{-1}$  associated with  $\text{C=O}$ ,  $\text{CH}_3$  and  $\text{C-N}$  vibrations. Isotopic substitution with  $^2\text{H}$  has confirmed some of these assignments. Some *ab initio* calculations also support the assignments. Additional work with  $^{13}\text{C}$  and  $^{15}\text{N}$  has been performed, but the results have not been fully analyzed. None of these signals can be produced by direct photolysis of the parent, which causes quantitative conversion to methyl isocyanate,  $\text{CH}_3\text{NCO}$ .

These observations provide strong evidence that acetylnitrene has been isolated for the first time. They also provide very interesting experimental verification, based on shifts in vibrational frequencies, for a surprisingly extensive electronic redistribution predicted earlier by theoretical calculations on the nitrene and its stable analog acetamide,  $\text{CH}_3\text{CONH}_2$ . Conclusion of this

research will involve further isotopic substitution to enable a full normal mode vibrational analysis, and

possibly some experiments with different matrix media or MET agents.

### **A Badge System for Monitoring Personal Exposure to Carbon Monoxide**

Researcher: Assistant Professor Jeffrey P. Fitzgerald

Sponsor: U.S. Army Biomedical Research and Development Laboratory

A carbon monoxide (CO) sensitive dosimeter badge was developed. Low concentrations of iron(II) tetraphenylporphyrin or iron(II) octaethyltetraazaporphyrin were incorporated into a polystyrene film, and the spectroscopic response of the film on exposure to different gases was examined. The films were found to be stable in air

and to undergo a color change, detectable by visible spectroscopy, within 30 minutes of exposure to one atmosphere of CO at room temperature. On replacement of the CO atmosphere with air, the film reverted back to its original spectrum within 45 minutes. Five such cycles were demonstrated with little decay in the response of the film.

### **Computer Program Implementation of Hazardous Materials Used by the Navy**

Researcher: Associate Professor Frank J. Gomba

Sponsor: Carderock Division, Naval Surface Warfare Center, Annapolis Detachment

Using a Hazardous Material Inventory System Program on CD ROM supplied by DoD, the researcher is developing Hazardous Material Worksheets for all hazardous materials used by the U. S. Navy, using a coding system developed for

easy retrieval of information as to health hazards and handling of such material. In addition, suggestions are being made on substitute materials to replace the existing hazardous materials used.

### **Synthesis of Inorganic Molecular Solids with Unusual Electrical or Magnetic Properties**

Researcher: Assistant Professor William B. Heuer

Sponsor: Naval Academy Research Council (ONR)

Historically, most work on molecular conductors and ferromagnets has utilized strictly planar components, since face-to-face stacking was thought to be necessary to promote the desired strong intermolecular interactions in these classes of crystalline solids. More recent work has shown that side-by-side stacking of non-planar, sulfur-rich organic donors can also give rise to strong interactions and high conductivity.

The objective of this project is to prepare new types of molecular precursors by using coordinated transition metal centers to introduce non-planarity into otherwise planar organo-chalcogen donor moieties.

Several complexes of this type have been obtained in low yield, and await full characterization. Uli-

mately, these products will be used in the preparation of crystalline charge-transfer salts, whose electrical and magnetic properties will be investigated.

The preparation of a series of transition metal complexes incorporating chelating croconate and dithiocroconate anions as ligands has recently been undertaken. Few complexes of these ligands have been described, although the available characterization data suggest that such complexes should serve as strong electron acceptors. The researcher seeks to synthesize and fully characterize a series of complexes of these ligands, and to incorporate these complexes into charge-transfer salts as described above.



## **High Pressure and Low Temperature Electrical Properties of $\beta$ - and $\beta'$ -Aluminas: Synthesis and Characterization of New Materials**

Researcher: Assistant Professor Joseph F. Lomax

Sponsor: National Science Foundation

$\beta$ - and  $\beta'$ -aluminas have a number of interesting properties, many of which arise because of the ability of these materials to incorporate a very large variety of ions into their structure. The incorporation of +1 ions is common in these materials, and their ion conductivity has been widely measured. However, +2 ions are less commonly incorporated into solid state ionic materials, and +3 ions have only been incorporated into  $\beta'$ -alumina. The limits to the charge of ions that can be incor-

porated into these materials has been expanded by this project. The work has demonstrated the ease with which +4 ions of titanium, zirconium, and hafnium can be incorporated. The mechanism for ion movement and the preferred positions for the exchanged ions in the material have been investigated by dielectric measurements at low temperature. Other new materials with interesting optical properties are also being synthesized using trivalent rare-earth metals.

## **Crystal Structure Determinations on the Chemistry Department X-ray Diffractometer**

Researcher: Assistant Professor Wayne H. Pearson

Sponsor: Naval Academy Research Council (ONR)

Installation of the Chemistry Department x-ray diffraction system was completed in January 1992. Since that time a number of crystal structures have been solved using the facility, in collaboration with researchers at the Naval Academy and other universities. The crystal structures solved include

$\text{Mo}(\text{cp}^*)(\text{PPhMe}_2)_2 \text{Cl}_2$ ,  $\text{Mn}(\text{OEP})$ , and  $\text{Fe}_2\text{DPPE}$ . Work is beginning on determining zirconium occupation in  $\beta$ -alumina compounds, and on electron density studies in para-substituted nitrobenzenes.

## **The Development of Diffusional Kinetics Models for Describing the Interleukin-2 Signal Transduction System**

Researcher: Associate Professor Boyd A. Waite

Sponsor: Naval Medical Research Institute

A theoretical foundation has been developed for describing diffusional interactions at and within cell surfaces. In particular, diffusional encounter rates for macromolecules impacting on cell surfaces, as well as diffusional encounter rates for species confined to the two-dimensional surface, have been developed. Key to these models are the theories developed previously for describing the detailed nature of the interactions of three-dimensionally

diffusing particles with surfaces. Calculations of signalling rates have been performed, with parameters selected to simulate certain features of the interleukin-2 system in T-cell immunology, one of the most studied signal transduction systems experimentally. Efforts were made to distinguish between two proposed mechanisms, which involve distinct receptor clustering strategies prior to binding of the IL-2.

## Dinuclear Reductive Elimination of Transition Metal Alkyl or Acyl Complexes with Transition Metal Hydride Complexes

Researcher: Lieutenant Keith E. Warner, USNR

Sponsor: Naval Academy Research Council (OMN)

The intent of this research is to probe the details and expand the scope of the dinuclear reductive elimination reaction of transition metal alkyl carbonyl complexes. Presently, the objective is to determine the factors that give rise to different types of organic products (alkane or aldehyde) from these complexes. It is important to examine these factors independently of the pathway(s) that generate a vacant site on the alkyl carbonyl complex. Thus the direct reaction of the metal hydride with the transition metal containing the organic fragment can be investigated.

Initial efforts have been directed at the synthesis of coordinatively unsaturated alkyl and acyl complexes of osmium. When heated in  $\text{CH}_3\text{CN}$ ,  $\text{Et}_2\text{Os}(\text{CO})_4$  forms isomers of the type:  $\text{Et}(\text{EtCO})\text{Os}(\text{CO})_3\text{s}$ , where  $\text{s} = \text{CH}_3\text{CN}$ . Unfortunately,  $^1\text{H}$  NMR patterns are complex, and unambiguous identification of the species in solution was not possible. Furthermore, it was not possible

to isolate these species. However, heating  $\text{R}(\text{Cl})\text{Os}(\text{CO})_4$  complexes in  $\text{CH}_3\text{CN}$  (where  $\text{R} = \text{Me, Et}$ ) has led to spectroscopically observable solvated complexes. Since these complexes are solvates, they have proven too unstable to isolate. However, they can be cleanly and reproducibly generated in solution. Furthermore, the solvate,  $\text{Me}(\text{Cl})\text{Os}(\text{CO})_3\text{s}$ , has been produced from the reaction of  $\text{ONMe}_3$  with  $\text{Me}(\text{Cl})\text{Os}(\text{CO})_4$  in  $\text{CH}_3\text{CN}$  solution.

Now that coordinatively unsaturated osmium complexes are available, kinetic investigations of the reaction of these complexes with metal hydrides can be undertaken. Further work is in progress involving (1) utilization of  $\text{ONMe}_3$  to generate other solvates such as  $\eta^5\text{-CpRe}(\text{CO})(\text{R})(\text{COR})(\text{s})$  for study with metal hydrides, and (2) extension of the dinuclear elimination reaction to transition metal carbene complexes.

## Applications of Molecular Mechanics to Transition State Modeling

Researcher: Midshipman 1/C John C. Mohs, USN

Adviser: Assistant Professor Debra K. Heckendorn

Sponsor: Trident Scholar Program

The use of modeling to predict chemical reactivity is of great utility to laboratory chemists. Molecular modeling of reactants and products, as well as determination of their energies and conformations, can be performed using commercially available software. Predictions of reactivity depend, as well, on the energies of transition states. These species cannot currently be modeled with simple computer software and generally can only be determined by *ab initio* or semi-empirical calculations. The use of high-level calculations by laboratory chemists is generally restricted by demands of time and computer access.

A molecular modeling approach to quantitatively predicting reactivity was developed by integrating results from high-level calculations into a commercial molecular modeling program. The specific systems of interest are lactonization and intra-molecular Michael addition. Transition state structure and energy were determined by quantum

mechanical calculations. The intermolecular attack of water upon protonated formic acid and the attack of water on the  $\beta$ -carbon of protonated acrylic acid were used to simulate the intramolecular reactions. The transition state geometries were determined at the AM1 level of calculations. The use of simplified systems such as these is necessary when carrying out quantum mechanical calculations due to demands for computer time and disk space.

Results of the AM1 calculations were then used to develop new parameters for molecular modeling. The geometries gave information about bond angles and distances in the transition state. Force constants for bond stretching and bending were determined empirically. The usefulness of these parameters was determined by comparing energy differences between reactants and transition states to rates of reaction available in the literature. The general trends predicted by molecular modeling are well correlated with these results.

## Synthesis and Characterization of Dipolar Organic Molecules for Investigation as Nonlinear Optical Materials

Researcher: Midshipman 1/C Dennis J. Rivet, USN

Adviser: Assistant Professor William T. Lavell

Sponsor: Trident Scholar Program

The goal of this project was to prepare dipolar, rigid-rod organic molecules for nonlinear optical studies. During the last year, the synthesis of three distinct types of materials was attempted.

Two amphiphilic donor-acceptor substituted azo dye esters were prepared from a common azo acid intermediate, obtained from coupling of N,N-di-octadecylaniline (prepared from dioctadecylamine and 4-fluoro-nitrobenzene) with p-benzenediazoniumcarboxylic acid tetrafluoroborate. These dyes will be oriented at a hydrophobic-hydrophilic interface. Partitioning and second-harmonic generation experiments are in progress.

A proposed nine-step synthesis of a polymeric dipolar imine was completed through six steps. The

intermediate compound, 1-phenyl-4-aminopiperidine, was prepared with low overall yield from 4-piperidinol and 4-fluoronitrobenzene. Improvements in this route are being developed.

A proposed three-step synthesis of a polymeric polypyridine vinylene was completed through two steps. The 6-Methylnicotinic acid was reduced with borane-THF, and the resulting alcohol oxidized with pyridinium chlorochromate to give 2-methyl-5-pyridinecarboxaldehyde. The self-condensation of this intermediate to give a dipolar, conjugated, electron-deficient polymer is being investigated. This project was also supported by the AT&T Bell Laboratories.



## Independent Research

### Electrochemical Reduction of Fluorenone and Benzophenone in a Room-Temperature Molten Salt

Researcher: Associate Professor Graham T. Cheek

The electrochemical behavior of fluorenone and benzophenone has been investigated in the aluminum chloride : 1-methyl-3-ethylimidazolium chloride molten salt system. Cyclic voltammetric studies have shown that melt acidity greatly influences the reduction potential of these ketones by complexation of the carbonyl oxygen by aluminum chloride in the acidic melt. The lifetime of the electrochemically generated ketyl also depends on melt acidity, becoming longer (more stable) as acidity increases. Preparative electrolyses have shown that reduction of fluorenone in the basic melt gives the pinacol (one-electron, dimeric)

product, whereas benzophenone reduction forms the alcohol (two-electron, monomeric) product. In the neutral melt, buffered with sodium chloride, both ketones undergo reduction to form a pinacolone product, resulting from initial pinacol formation followed by rearrangement induced by oxide abstraction by the melt. Further evidence of oxide uptake by the melt is found in the reduction of fluorenone in the acidic melt, in which the pinacolone product and a small amount of bifluorenylidene (alkene, both oxygens removed) is formed.

### Synthesis of Redox-active Ion-binding Transition Metal Complexes

Researcher: Assistant Professor William B. Heuer

Redox-active molecules possessing ion-binding functionality have been proposed as components of molecular ion sensors or controlled-release systems for ions. The preparation of a series of electrochemically-active transition metal complexes has been undertaken in which pendant crown-ether groups will provide the requisite ion-binding function. Synthesis of the specific functionalized

crown ether macrocycle required for this work is nearly complete. Future work will involve appending this macrocycle to metal complexes containing oxygen atoms in the coordination sphere of the metal. It is anticipated that these oxygen atoms will provide a strong pathway for communication between the bound ion and the redox-active transition metal center.

### The Rate of the Hydrogen Isotope Exchange Reaction on cis-Dichloroplatinium (II)

Researcher: Professor Edward Koubek

The rate of the N-H→N-D exchange reaction for cis-PtCl<sub>2</sub>(NH<sub>3</sub>)<sub>2</sub>, PtCl<sub>2</sub>(en), and PtCl<sub>2</sub>(tn) has been measured in succinate buffered D<sub>2</sub>O. Samples of the complex were precipitated as the HgCl<sub>2</sub> adduct, at various times, and the extent of deuteration was estimated by IR spectroscopy. The rate of the reac-

tion is proportional to the [OD<sup>-</sup>], and activation parameters for the three complexes (I=0.1 M NaCl, 25.0°C) in the order (NH<sub>3</sub>)<sub>2</sub>, (en), (tn) are: 10<sup>4</sup> k<sub>ex</sub> (M<sup>-1</sup> s<sup>-1</sup>) 135, 51.4, 3.64; ΔH<sup>‡</sup> (kJ mol<sup>-1</sup>) = 24.9, 21.2, 50.0; ΔS<sup>‡</sup> (J K<sup>-1</sup> mol<sup>-1</sup>) = -44.1, -64.6, + 10.2.

## Photochemical Study of Cyano-Isocyanide-Phosphine Complexes of Iron and Ruthenium

Researcher: Associate Professor Joyce E. Shade

The chemistry of carbonyl-cyano-phosphine complexes of iron has been studied extensively for the last ten years. In general, reflux or photolytic reaction conditions have been employed to initiate the loss of a carbonyl (CO) group from cyclopentadienyl-iron-carbonyl starting materials with a subsequent inclusion of a phosphine or phosphite ligand on the metal center. The resulting complexes obtained in these studies, however, all contain at least one carbonyl group. The purpose of this research was to prepare a series of anionic, neutral and cationic cyano, mono- and bisisocyanide complexes for reaction with phosphine or phosphite groups under photolytic conditions.

Photolysis of the monoisocyanide complex,  $(C_5H_5)Fe(CO)(CN)(CNCH_3)$ , in the presence of a slight excess of triphenylphosphine at room temperature gave the desired product  $[(C_5H_5)Fe(CN)(CNCH_3)(PPh_3)]$  with loss of one equivalent of carbon monoxide. Two additional products have been obtained, however:  $(\eta^5-C_5H_5)Fe(CNCH_3)_2(CN)$  and  $(\eta^5-C_5H_5)Fe(CN)(PPh_3)_2$ . Similar results were obtained with a variety of phosphine, phosphite, arsine, and antimony ligands. Several of the reac-

tion products have been isolated from the fairly clean reaction mixtures, and a variety of spectral data has been obtained to verify their identity. Further purification and characterization of these compounds are continuing. In addition, trends of reaction product yields with bulk and basicity of ligand are being studied. Effect of ligand identity (both on the metal prior to photolysis and as an incoming group), wavelength of the photolysis lamp, and temperature of the reaction mixture are being studied as they affect the reaction products obtained. Anionic and cationic starting materials are being investigated under a variety of reaction conditions in order to analyze the system for any trend which might develop as a function of complex charge. A collaborative effort was established with The University in Southampton in an effort to establish conclusively the identity of the reaction intermediate(s). The results of this work have been very promising, and the identity of the reaction intermediate has been postulated, as a result of low-temperature matrix isolation studies conducted at Southampton. Work on the project is continuing with a shift in focus to the analogous ruthenium species.

## Synthesis of Cyclopentadienyl-Ruthenium Complexes Containing $n^2$ -diarsene Ligands

Researcher: Associate Professor Joyce E. Shade

The purpose of this project was to investigate the synthetic pathways possible for the generation of cyclopentadienyl-ruthenium complexes containing  $n^2$ -diarsene ligands. Complexes of this type which contain chromium, molybdenum, and tungsten have been investigated by several research groups. Recently, complexes containing zirconium, niobium, and tantalum as the metal centers have been successfully synthesized, isolated in very small yields, and characterized by nuclear magnetic resonance and x-ray diffraction studies. These complexes are interesting due to the fact that the di-hapto ligand would be isolobally analogous to an organic olefin.

Preliminary experimental work has been started, and the  $[Cp^*RuCl_2]_n$  starting material has been synthesized in reasonable yields. Synthesis of the cycloarylsarsine, cyclo-(TolAs)<sub>5,6</sub>, has been accomplished following the reported literature methods that begin with p-toluidine. In this scheme,

the p-toluidine is converted to p-toluidine diazonium perfluoroborate, which is then converted to p-tolylarsonic acid using  $As_2O_3$ . Final isolation of the cyclic tolylsarsine is accomplished through a reduction of the acid solution using hypophosphorous acid. The resultant arsenotoluene product is a mixture of both the five- and six-membered rings in various ratios. Reactions of the cyclotolyarsine with the polymeric ruthenium species mentioned above have been attempted under various experimental conditions. Because of the polymeric nature of the metal starting material and the mixed stoichiometry of the arsine species, it has been difficult to determine the exact reaction conditions needed to insure reaction of the compounds rather than decomposition of one or both of the starting materials. To date, definitive results have not been obtained, but work on the project is still in progress.

# Research Course Projects

## Synthesis and Characterization of Organometallic Complexes

Researcher: Midshipman 1/C Thomas P. Daily, USN  
 Advisers: Associate Professor Joyce E. Shade and  
 Assistant Professor Wayne H. Pearson

Photolysis of the dinuclear iron complexes,  $[\text{CpFe}(\text{CO})]_2\text{-u-DPPX}$  where DPPX = DPPM, DPPE and DPPP and, therefore, are  $(\text{Ph}_2\text{P})_2\text{CH}_2$ ,  $(\text{Ph}_2\text{P})_2\text{C}_2\text{H}_4$ , and  $(\text{Ph}_2\text{P})_2\text{C}_3\text{H}_6$ , respectively, have been conducted in chloroform using infrared light. In contrast to the simple iron carbonyl dimer  $[\text{CpFe}(\text{CO})_2]_2$  which forms  $\text{CpFe}(\text{CO})_2\text{Cl}$  under photolytic reaction conditions, the phosphine-containing materials yield a golden dimeric product which contains the phosphine substituent intact as a bimetallic bridge. In the case of the DPPM and DPPE systems, incorporation of chloride ligands from the solvent is not observed. However, formation of a formyl substituent on one of the previously symmetrical cyclopentadienyl rings has

been confirmed spectroscopically through infrared analysis, multinuclear NMR, and x-ray diffraction studies. The proposed mechanism for the formation of such a complex appears to involve a radical intermediate and follows a modified Reimer-Tiemann reaction. Such a pathway is believed to be unprecedented in the photochemistry of bimetallic complexes. In the case of the DPPP complex, the golden product that is isolated also contains the phosphine substituent as a bimetallic bridge. The bidentate ligand, however, appears to be too long to allow a metal-metal bond, and the resulting product contains symmetrical cyclopentadienyl rings on each iron center along with the chloride ligand and a carbonyl group.

## Synthesis of Novel, Sulfur-rich Bridged Biferroceneophanes

Researcher: Midshipman 1/C Steven J. Gauerke, USN  
 Adviser: Assistant Professor William B. Heuer

Bridged biferrocenes are of continuing interest to physical and inorganic chemists because of their potential to exhibit mixed valency and/or multiple electron transfer properties. Sulfur-rich organic and organometallic donor species are likewise of interest to solid state chemists owing to the ability of sulfur atoms to mediate significant intermolecular interactions which can give rise to unusual electrical or magnetic properties. The objective of this project is to use established synthetic methods to prepare a series of novel biferroceneophanes incor-

porating planar, sulfur-rich groups having delocalized electronic structures. Ferroceneophanes incorporating dithiocarbonate and trithiocarbonate groups have been prepared in low yields, and investigations are currently aimed at improving yields and coupling these precursors to form the desired biferroceneophanes. The dithiocarbonate precursor has been found to undergo photoinduced polymerization to give poly(ferrocenedisulfide). The properties and potential applications of this novel polymer are being investigated.

## Methodology for the Synthesis of gamma-Butyrolactones

Researcher: Midshipman 1/C P. Bradford Hutton, USN  
 Adviser: Assistant Professor Debra K. Heckendorn

Many terpenoid natural products contain gamma-butyrolactones as an essential structure feature. In

some systems, this ring is crucial for biological activity. For this reason, strategies for preparation

of this type of lactone are of current synthetic interest. The ability to introduce various substitution patterns in a facile, short synthesis is particularly appealing. The focus of this project is the development and optimization of a general methodology for the synthesis of gamma-butyrolactones. The methodology being developed uses a key intermediate which can selectively be converted to a variety of lactones. This key intermediate is prepared by a Diels-Alder reaction. The ability of the Diels-Alder reaction to prepare substituted cyclohexenes with high regio- and stereoselectivity is well known. Using a Diels-Alder reaction in the first step of the synthesis gives a cyclohexene ring with well-controlled and variable substitution patterns.

Conversion of these cyclohexenes to butyrolactones can be carried out in two ways. The first involves formation of an alcohol on a carbon adjacent to the cyclohexene ring. Ozonolysis of this alcohol, followed by an oxidative work-up, produces a gamma-butyrolactone with substituents at the  $\beta$

and  $\gamma$  positions. Several different substituents have been introduced with uniformly satisfactory results. Only three steps are required for this entire synthesis.

The second method of production of butyrolactones uses the same Diels-Alder product. In this method, a carboxylic acid is introduced as a substituent on the cyclohexene ring. Ozonolysis of this compound proceeds smoothly. A reductive work-up is then needed to produce an alcohol which could become involved in lactonization. To date, promising results have been seen, but this method cannot be considered to be fully optimized.

The successful production of a variety of substituted  $\gamma$ -butyrolactones has opened up new avenues for investigation. Further work is being undertaken to extend the types and positions of substituents on the butyrolactones produced by this methodology. The development of a method for production of  $\alpha$ -substituted butyrolactones will be investigated.

## Preparation and Alkylation of Bicyclo[3.3.0]octanes

Researcher: Midshipman 1/C Donald J. Lane, USN

Adviser: Assistant Professor Debra K. Heckendorn

Investigation of the dolabellane class of diterpenes uncovered a need for methodology into the production of highly substituted cyclopentane rings. A new way to prepare these systems based upon the chemistry of bicyclo[3.3.0]octanes is being investigated. These systems are sterically constrained to exist in a single conformation. Substituents are being introduced stereospecifically utilizing this conformational rigidity.

The preparation of the bicyclic systems needed for this investigation was investigated first. Early efforts to prepare these systems by intramolecular alkylation did not produce the desired systems but did open interesting avenues of research in molecular modeling. A successful approach to the bicyclic systems based upon a Diels-Alder reaction, followed by ozonolysis, gave a  $\gamma$ -butyrolactone with a three-carbon ester side-chain. Dieckman cyclization of this material produced the desired bicyclo[3.3.0]octane. This step initially gave low yields due to hydrolysis of the product during the

work-up. Development of modified work-up conditions involving trapping of the intermediate enolate and subsequent hydrolysis of the enol ether gave excellent yields. In addition, the new work-up allowed for preparation of bicyclic systems on large scale.

Alkylation of these systems at the ring junction was investigated. This position was easily deprotonated with base, and alkylations gave single products in high yields. A variety of alkylation agents were used with uniformly good results. Introduction of substituents at positions away from the ring junction is also being investigated. Encouraging preliminary results are being investigated to determine that the stereochemistry of the additions was consistent with predictions. Once these stereochemical proofs are completed, further derivatization will be carried out to produce intermediates suitable for use in dolabellane diterpene synthesis.

## Calculated Circular Dichroism of the $^1L_b$ Aromatic Vibronic Bands

Researcher: Midshipman 1/C John E. McGunnigle, Jr., USN

Adviser: Assistant Professor Ronald E. Siatkowski

Numerous attempts have been made at theoretically assessing the chiroptical contributions of dissymmetric molecular systems containing at least one aromatic chromophore. Yet, to date, no examples have been published which attempt to quantify the relationships between the  $^1L_b$  vibronic chiroptical properties and molecular structure. In view of the apparent potential of using the  $^1L_b$  vibronic chiroptical bands as a probe of molecular structure for dissymmetric molecules, it was thought to be worthwhile to investigate theoretically the structure-chiroptical relationships of suitable chiral alkyl-benzenes. Specifically, the calculated circular dichroism (CD) spectrum for the aromatic  $^1L_b$  vibronic fine structure bands of several energy-minimized structures were computed using the Johnson-Tinoco theory. By employing a Taylor-expansion and keeping only the first two terms of the series, the Johnson-Tinoco theory permits the computation of the CD through the system's rotational strengths. The results of the CD calculations

are presented in terms of CD-energy conformational maps. This was accomplished using a computer program in Fortran IV, which was written for a mainframe computer. The calculated values produced by this program are in good agreement with the experimental results. The calculated results show, at least for the  $^1L_b$  vibronic band region in aromatic molecules, the importance of including dipole x polarizability interactions in CD calculations. These results indicate, for the first time, that the CD of the  $^1L_b$  aromatic vibronic bands may be used as a sensitive probe of the molecular structure. A manuscript reporting these findings is in preparation.

In order to make the CD calculation program more accessible, the development of a computer program in C++ was undertaken for use on a personal computer. The C++ program is completely restructured from the Fortran program for improved readability and writability. Development of the C++ code is continuing.

## Synthesis and Characterization of Zirconium Exchanged $\beta$ "-Aluminas

Researcher: Midshipman 1/C Katie J. Patrick, USN

Adviser: Assistant Professor Joseph F. Lomax

Ion exchange has been accomplished upon the reaction of  $ZrCl_4$  with Na- $\beta$ "-alumina. Changes have been noted in the x-ray powder crystallography, elemental analyses, optical properties, and especially in the low temperature audio frequency complex impedance measurements. Complex impedance measurements are particularly sensitive to motion of bound dipoles, usually involving an aliovalent ion, as well as dc conductivity within the material. In all samples electrical relaxation peaks are observed (probably associated with sodium ion motion), and where possible,  $E_{act}$

for the motion has been determined. Grain boundary effects are thought to be important in the results for the powder samples.  $E_{act}$  and conductivity have been determined for both crystalline and powder samples. In crystalline samples the growth and subsequent disappearance of at least three dielectric loss features have been found, along with reduced conductivity upon increased reaction time in the case of Na- $\beta$ "-alumina treated with  $ZrCl_4$  (400°C; 18-330 h). This project was also supported by the National Science Foundation.



## Tetraazaporphyrins: Theory and Experimental Evidence Indicate Different Electronic Configurations than Related Porphyrins

Researcher: Midshipman 1/C Nichol K. Sturdevant, USN

Adviser: Assistant Professor Jeffrey P. Fitzgerald

Tetraazaporphyrins (TAPs), a class of aromatic, macrocyclic ligands made of four pyrrole rings bridged by aza nitrogen atoms, are of interest due to their unique optical electrochemical and catalytic properties when compared to the structurally similar and biologically important porphyrins (Ps). In this project, an attempt has been made to understand the different properties of TAPs versus Ps based on differences in their electronic structure.

Huckel molecular orbital calculations were made on a generic metallotetraazaporphyrin and were compared to those already published for a metalloporphyrin. The most obvious difference was that the TAP molecular orbitals which had a large coefficient on the bridging aza nitrogen atoms were lower in energy than the corresponding P molecular orbitals. This was rationalized as being due to the greater electronegativity of nitrogen versus carbon. Given the electronic configurations of both TAPs and Ps, several predictions were made. First, TAP oxidation and reduction potentials should both be shifted positive relative to P redox potentials. Sec-

ond, TAP visible spectra, which depend upon the energy difference between occupied and unoccupied orbitals, will be very different from those of Ps. Third, the highest occupied molecular orbital (HOMO), which loses an electron when the macrocycle is oxidized, has different symmetry in a TAP versus a P.

Several of the above predictions were confirmed experimentally. Zinc octaethyltetraazaporphyrin, a new substance, was prepared, purified, and characterized by visible and NMR spectroscopies, by elemental analysis, and by cyclic voltammetry. The experimentally-measured visible spectrum qualitatively matched the spectrum predicted from the TAP calculation. The TAP first oxidation and reduction potentials were measured at +1.1 and -1.05 (v vs SCE), respectively. These are shifted 400 mv and 600 mv positive of the respective P potentials. Attempts to show different symmetry in the HOMO of TAP versus P have so far failed for experimental reasons.



## Publications

CAMPBELL, Mark L., Assistant Professor, "Having Fun with the Metric System," *Journal of Chemical Education*, 68 (December 1991), 1043.

A pedagogical method is described to add levity when teaching the metric system prefixes.

CHEEK, Graham T., Associate Professor, "Quartz Crystal Microbalance Studies of the Nickel Hydroxide System," *Proceedings of the Electrochemical Society*, PV-17 (1991), 248-256.

The electrochemical reactions occurring in the nickel oxide electrode system have been studied with the quartz crystal microbalance. Following cathodic deposition from nickel sulfate solutions, the nickel hydroxide films were cycled in 1.0 M alkali metal hydroxide solutions. The oxidation process produced frequency decreases in these solutions, indicating a corresponding increase in mass in the electrode layer. Upon subsequent reduction, a return to the initial frequency value was observed. These shifts ranged from a relatively small change for lithium hydroxide to progressively larger shifts as the cation size increased, with values for rubidium and cesium being approximately the same. It is clear from these results that alkali metal cations are being taken up into the electrode structure during oxidation. A mechanism based upon a net 1.67 electron oxidation has been proposed, involving oxidation of nickel from the 2+ to the 3+ state, with the remaining charge producing active oxygen in the form of hydroxyl radical which remains in the electrode. Previous EXAFS studies have revealed that the nickel 4+ state is not involved in this oxidation. The mechanism is consistent with the quartz crystal microbalance data provided that alkali metal cations enter, and water molecules leave, the electrode during oxidation.

D'ALESANDRO, Michele M., Lieutenant Commander, USN, co-author, "Hematological Parameters are Altered during Cold Air Exposure," *Arctic Medical Journal* 1 (1992), 16-22.

Whole blood hematocrit (HCT) decreases during multiple exposures to cold air. To better understand this finding, hematological profiles were analyzed in 27 normal adult men exposed repeatedly to cold air in one of two experimental protocols. Experiment I was a cold air acclimatization study (CAA) conducted with two groups of 8 men in each group before, during, and after 80 separate 30-minute cold (4°C) air exposures. As part of a metabolic study, half of the men received placebo

daily ( $n = 8$ ), and the other half received an oral daily maintenance dose of the thyroid hormone triiodothyronine ( $T_3$ ) (30  $\mu\text{g/day}$ ). Blood was analyzed prior to and after every 20 cold exposures. Both groups reacted similarly. When compared with basal conditions, hematocrit (HCT) and erythrocyte counts (RBC) were decreased ( $p < 0.05$ ); mean corpuscular hemoglobin concentration (MCHC) and plasma volume (PV) were increased with cold exposure ( $p < 0.05$ ). Hemoglobin (Hb), leukocyte counts (WBC), and mean corpuscular volume (MCV) were unchanged.

Experiment II was carried out with 9 military volunteers during extended arctic winter field operations (EAO) in Utah and Alaska. Blood was analyzed prior to and after completion of EAO. A changing hematological profile similar to that in the CAA protocol was found. Hematocrit and RBC were decreased ( $p < 0.02$ ); MCHC and PV were increased ( $p < 0.02$ ). Hemoglobin, WBC, and MCV were unchanged. In addition, there was a negative correlation between HCT and the absolute reticulocyte count in this second experiment. It would appear that in instances of cold stress, whether induced or naturally occurring, certain blood cellular elements respond in a similar adaptive manner.

D'ALESANDRO, Michele M., Lieutenant Commander, USN, co-author, "Radioprotection by Polysaccharides Alone and in Combination with Aminoethiols," *Advances in Space Research*, 12 (1992), 233-248.

It was demonstrated that glucan, a beta-1,3 polysaccharide immunomodulator, enhances survival of mice when administered before radiation exposure. Glucan's prophylactic survival-enhancing effects are mediated by several mechanisms, including (1) increasing macrophage-mediated resistance to potentially lethal postirradiation opportunistic infections, (2) increasing the  $D_{50}$  of hematopoietic progenitor cells, and (3) accelerating hematopoietic reconstitution. In addition, even when administered shortly after some otherwise lethal doses of radiation, glucan increases survival. Glucan's therapeutic survival-enhancing effects are also mediated through its ability to enhance macrophage function and to accelerate hematopoietic reconstitution; glucan's therapeutic potential, however, is ultimately dependent on the survival of a critical number of hematopoietic stem cells capable of responding to glucan's stimulatory effects. Preirradiation administration of the traditional aminoethiol radioprotectants WR-2721

and WR-3689 has been previously demonstrated to be an extremely effective means to increase hematopoietic stem cell survival. Therapeutic glucan treatment administered in combination with preirradiation WR-2721 or WR-3689 treatment synergistically increases both hematopoietic reconstitution and survival. Such combined modality treatments offer new promise in treating acute radiation injury.

FITZGERALD, Jeffrey P., Assistant Professor, co-author, "Facile Synthesis of Substituted Fumaronitriles and Maleonitriles: Precursors to Soluble Tetraazaporphyrins," *Synthesis* (September 1991), 686-688.

Alkynes are converted in good yield to alkyl and/or aryl substituted fumaronitriles and maleonitriles, a rich source of precursors to soluble tetraazaporphyrins.

FITZGERALD, Jeffrey P., Assistant Professor, co-author, "Iron Octaethyltetraazaporphyrins: Synthesis, Characterization, Coordination Chemistry, and Comparisons to Related Iron Porphyrins and Phthalocyanines," *Inorganic Chemistry*, 31 (May 1992), 1852-1860.

This paper describes the synthesis and characterization of a series of iron octaethyltetraazaporphyrin complexes and compares these substances to related iron porphyrins and phthalocyanines. Experimental evidence provided by magnetic susceptibility measurements,  $^1\text{H}$  NMR, EPR and Mössbauer spectroscopies, cyclic voltammetry, and/or x-ray crystallography indicates the tetraazaporphyrin ligand is a stronger  $\sigma$  donor and  $\pi$  acceptor than is a porphyrin ligand. Due to its high basicity, the tetraazaporphyrin ligand stabilizes the unusual  $S = 3/2$  spin state for iron in chloroiron(III) octaethyltetraazaporphyrin. Yet the high acidity of the tetraazaporphyrin ligand shifts iron III/II redox potentials 400 mv positive of those for analogous iron porphyrins. In this sense, the tetraazaporphyrin macrocycle is more like a phthalocyanine than a porphyrin. Compared to phthalocyanines, octaethyltetraazaporphyrins are readily soluble. The high solubility, unusual metal spin states, and positively shifted redox potentials of octaethyltetraazaporphyrins suggest that they may have better or unique catalytic properties compared to porphyrins and phthalocyanines.

HEUER, William B., Assistant Professor, co-author, "Polarized Specular Reflectance Spectra of the Partially Oxidized Phthalocyanines  $\text{Cu}(\text{pc})\text{I}$  and  $\text{H}_2(\text{pc})\text{I}$  Compared to Those of  $\text{Co}(\text{pc})\text{I}$  and

$\text{Ni}(\text{pc})\text{I}$ : Metal-Based Charge-Transfer Transitions in One-Dimensional Conductors," *Inorganic Chemistry*, 31 (1992), 352-358.

Polarized single-crystal ultraviolet and visible specular reflectance spectra and Kramers-Kronig-transformed absorbance spectra of  $\text{Cu}(\text{pc})\text{I}$  and  $\text{H}_2(\text{pc})\text{I}$  are reported. Analysis of these spectra clarifies the assignment of metal-based charge-transfer transitions, especially when compared to previously published reflectance data for the isomorphous compounds  $\text{Ni}(\text{pc})\text{I}$  and  $\text{Co}(\text{pc})\text{I}$  and the results of recent band structure calculations on related porphyrinic systems. Earlier out-of-plane assignments have been confirmed by the present work, and some modified assignments are proposed for in-plane transitions, including the well-known Soret transition.

KOUBEK, Edward, Professor, co-author, "The Rate of the Hydrogen Isotope Exchange Reaction on cis-Dichloroplatinium (II)," *Inorganica Chimica Acta*, 191 (1992), 103-107.

The rate of the  $\text{N-H} \rightarrow \text{N-D}$  exchange reaction for  $\text{cis-PtCl}_2(\text{NH}_3)_2$ ,  $\text{PtCl}_2$ ,  $\text{PtCl}_2(\text{en})$ , and  $\text{PtCl}_2(\text{tn})$  has been measured in succinate buffered  $\text{D}_2\text{O}$ . Samples of the complex were precipitated as the  $\text{HgCl}_2$  adduct, at various times, and the extent of deuteration was estimated by IR spectroscopy. The rate of the reaction is proportional to the  $[\text{OD}^-]$  and activation parameters for the three complexes ( $I = 0.1 \text{ M NaCl}$ ,  $25.0^\circ\text{C}$ ) in the order  $(\text{NH}_3)_2$ ,  $(\text{en})$ ,  $(\text{tn})$  are:  $10^4 k_{\text{ex}} (\text{M}^{-1} \text{s}^{-1}) = 135, 51.4, 3.64$ ;  $\Delta H^\ddagger (\text{kJ mol}^{-1}) = 24.9, 21.2, 50.0$ ;  $\Delta S^\ddagger (\text{J K}^{-1} \text{mol}^{-1}) = -44.1, -64.6, +10.2$ .

LOMAX, Joseph F., Assistant Professor, John J. FONTANELLA, Professor, (Physics), and Mary C. WINTERSGILL, Professor, (Physics), "Disorder in  $\beta$ -aluminas: Dielectric Relaxation and X-ray Absorption," *Physical Review B*, 45 (1992), 6369-6375.

$\beta$ -aluminas substituted with rare-earth elements (Pr, Nd, Er, and Tb) and Sn have been studied using near-edge and extended x-ray-absorption fine structure (NEXAFS and EXAFS). In addition, dielectric-relaxation (DR) measurements have been made on  $\text{Na-}\beta$ -,  $\text{Na-}\beta''$ -, and  $\text{Na-Er-}\beta''$ -alumina. Both the DR and EXAFS results confirm that disorder, particularly in the conduction plane, in the vicinity of the rare-earth ions is a feature of the  $\beta$ -aluminas. The NEXAFS studies show that the rare-earth ions are ionized to trivalency and are highly localized; in contrast, Sn is clearly divalent, as in  $\text{SnO}$ .

WAITE, Boyd A., Associate Professor, and Mark L. CAMPBELL, Assistant Professor, "Response to 'Standard States for Water Equilibrium,'" *Journal of Chemical Education*, 69 (1992), 256.

There continues to be misunderstanding in the chemical education community concerning the meaning of "acid strength" as it pertains to water and the hydronium ion. This brief note is in response to an argument raised by Baldwin and

Burchill, [*J. Chem. Ed.*, 69 (1992), 255-256] concerning the appropriate application of standard states to equilibria involving water. It is pointed out that, depending on the aspect of acid strength being described, several standard state choices are plausible. When comparing the propensity for molecules to donate protons to nearby solvent molecules, the standard states proposed by Waite and Campbell, [*J. Chem. Ed.*, 67 (1990), 386-388] are appropriate.



## Presentations

CAMPBELL, Mark L., Assistant Professor, "Electronic Quenching of the  $B^2\gamma^+$  state of A10," Twentieth Informal Conference on Photochemistry, Atlanta, Georgia, 28 April 1992.

CHEEK, Graham T., Associate Professor, "Electrochemistry of Aromatic Ketones in a Room-Temperature Molten Salt," Fourth Chemical Congress of North America, New York, New York, 29 August 1991.

CHEEK, Graham T., Associate Professor, "Quartz Crystal Microbalance and EXAFS Study of the Nickel Hydroxide System," Gordon Conference on Electrochemistry, Ventura, California, 22 January 1992.

CHEEK, Graham T., Associate Professor, "Electrochemical Reduction of Aromatic Ketones in a Room-Temperature Molten Salt," 181st Electrochemical Society Meeting, St. Louis, Missouri, 20 May 1992.

D'ALESANDRO, Michele M., Lieutenant Commander, USN, co-author, "Changes in Porcine Serum Triiodothyronine ( $T_3$ ) Kinetics with Prolonged Exposure to Cold," Federation of American Societies for Experimental Biology, Bethesda, Maryland, 22 April 1992.

D'ALESANDRO, Michele M., Lieutenant Commander, USN, co-author, "Alteration in Thyrotropin, Total and Lipoprotein Cholesterol with Antarctic Residence," Federation of American Societies for Experimental Biology, Bethesda, Maryland, 22 April 1992.

D'ALESANDRO, Michele M., Lieutenant Commander, USN, co-author, "Changes in Porcine Triiodothyronine Distribution after Prolonged Cold Exposure Versus a Short-term Exposure," Federation of American Societies for Experimental Biology, Bethesda, Maryland, 22 April 1992.

ELERT, Mark L., Professor, co-author, "Simulations of Chemically-Sustained Shock Waves in Energetic Materials," American Physical Society Conference on Shock Compression of Condensed Matter, Williamsburg, Virginia, 18 June 1991.

ELERT, Mark L., Professor, co-author, "Molecular Dynamics Simulations of Shock Induced Chemistry: Application to Chemically-Sustained Shock Waves,"

NATO Workshop on Microscopic Simulations of Complex Hydrodynamic Phenomena, Alghero, Italy, 15 July 1991.

ELERT, Mark L., Professor, co-author, "Molecular Description of Chemically-Sustained Shock Waves: From Initiation to Continuum Behavior in a Hundred Picoseconds," Office of Naval Research Workshop on Desensitization of Explosives and Propellants, Delft, The Netherlands, 13 November 1991.

ELERT, Mark L., Professor, co-author, "Chemical Dynamics Simulations as a Probe to the Initiation and Propagation of Condensed Phase Detonations," Office of Naval Research/Los Alamos National Laboratories Workshop on the Fundamental Physics and Chemistry of Combustion, Initiation, and Detonation of Energetic Materials, Los Alamos, New Mexico, 4 March 1992.

ELERT, Mark L., Professor, co-author, "Shock Waves and Polymorphic Phase Transitions in Energetic Materials," Office of Naval Research/Los Alamos National Laboratories Workshop on the Fundamental Physics and Chemistry of Combustion, Initiation, and Detonation of Energetic Materials, Los Alamos, New Mexico, 4 March 1992.

ELERT, Mark L., Professor, co-author, "Molecular Dynamics Simulations of Detonations: From Atomic Scale to Continuum Behavior in Under a Hundred Picoseconds," American Physical Society National Meeting, Indianapolis, Indiana, 16-20 March 1992.

ELERT, Mark L., Professor, co-author, "Molecular Dynamics Simulations of Chemically-Sustained Shock Waves," American Chemical Society National Meeting, San Francisco, California, 6-10 April 1992.

FERRANTE, Robert F., Associate Professor, co-author, "Erbium in Silicon: Impurity-Enhanced Photoluminescence at 1.54 Microns," Electronic Materials Conference of the Minerals, Metals, and Materials Society, Boulder, Colorado, 21 June 1991.

FITZGERALD, Jeffrey P., Assistant Professor, "Metallotetraaza-porphyrins: Synthesis, Characterization and Comparison to Related Porphyrins and Phthalocyanines," Tenth Annual Ester Humphrey Symposium, University of Vermont, Burlington, Vermont, 14 September 1991.

FITZGERALD, Jeffrey P., Assistant Professor, "Iron Octaethyl-tetraazaporphyrins: Synthesis, Characterization, and Comparison to Related Macrocycles," American Chemical Society National Meeting, San Francisco, California, 10 April 1992.

HECKENDORN, Debra K., Assistant Professor, and P. Bradford HUTTON, Midshipman 1/C, USN, "Methodology for the Synthesis of Gamma-Butyrolactones," Forty-sixth Annual Eastern Colleges Science Conference, United States Naval Academy, Annapolis, Maryland, 4 April 1992.

HECKENDORN, Debra K., Assistant Professor, and Donald J. LANE, Midshipman 1/C, USN, "Preparation and Alkylation of Bicyclo[3.3.0]octanes," Forty-sixth Annual Eastern Colleges Science Conference, United States Naval Academy, Annapolis, Maryland, 4 April 1992.

HECKENDORN, Debra K., Assistant Professor, and John C. MOHS, Midshipman 1/C, USN, "Applications of Molecular Mechanics to Transition State Modelling," American Chemical Society National Meeting, San Francisco, California, 6 April 1992.

LAVELL, William T., Assistant Professor, and Dennis J. RIVET, Midshipman 1/C, USN, "Synthesis of Amphiphilic Azo Dyes for Second Harmonic Generation," Forty-sixth Annual Eastern Colleges Science Conference, United States Naval Academy, Annapolis, Maryland, 4 April 1992.

LAVELL, William T., Assistant Professor, and Dennis J. RIVET, Midshipman 1/C, USN, "Synthesis of An Amphiphilic Azo Dye for Second Harmonic Generation," American Chemical Society National Meeting, San Francisco, California, 6 April 1992.

LOMAX, Joseph F., Assistant Professor, Mary C. WINTERSGILL, Professor, (Physics), and John J. FONTANELLA, Professor, (Physics), "High Valence Insertion Products of  $\beta$ -Alumina: Preparation and Electrical Properties," Solid State Ionics Eighth International Conference, Lake Louise, Alberta, Canada, 20-26 October 1991.

SIATKOWSKI, Ronald E., Assistant Professor, and Keith E. HARTMAN, Midshipman 3/C, USN, "The Use of a Computer in the Interpretation of NMR Spectroscopy Data," Forty-sixth Annual Eastern Colleges Science Conference, United States Naval Academy, Annapolis, Maryland, 3-4 April 1992.

SIATKOWSKI, Ronald E., Assistant Professor, and John E. MCGUNNIGLE, Jr., Midshipman 1/C, USN, "Scientific Programming Using Object Oriented C++," Forty-sixth Annual Eastern Colleges Science Conference, United States Naval Academy, Annapolis, Maryland, 3-4 April 1992.

SIATKOWSKI, Ronald E., Assistant Professor, and John E. MCGUNNIGLE, Jr., Midshipman 1/C, USN, "Object Oriented C++ for Scientific Programming," Fifty-sixth Annual Intercollegiate Student Chemists Convention, Franklin and Marshall College, Lancaster, Pennsylvania, 11 April 1992.



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## Computer Science

Associate Professor Frederick A. Skove  
Chair

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**D**uring the 1991-1992 academic year, the Computer Science Department continued to conduct research and spread the Academy's name through publishing. The department encourages its faculty to seek summer support through outside funding. This year all but one NARC grant was turned back after receiving support from external sources. The Naval Research Laboratory and the Defense Mapping Agency have contributed significantly to our funding success.

This academic year, one faculty member, Dr. L.K. Chi, participated in a research exchange program with David Taylor Research Center, Carderock. As a result, Dr. Stuart Ullman of that center spent both semesters with us. He used the time to teach one section of a course, and together he and Dr. Chi continued studies of Fractal Data Compressions.

Dr. Andrew Phillips served as adviser to a Trident Scholar. As part of the research effort, he and Midshipman 1/C Matthew McLaughlin spent a full week at the University of Minnesota Supercomputer Institute in support of the project, "Implementation of a Parallel Solving Method for Linearly Constrained Concave Global Optimization Problems Using Parallel Computing." During this week Midshipman McLaughlin used one hour of supercomputer time. Experiences such as this greatly enhance the education of midshipmen.

The Computer Science Department had an extremely productive year. Overall, there were twenty publications, twenty-five presentations and four technical reports.





## **Sponsored Research**

### **Fractal Data Compressions**

Researcher: Professor Frank L. K. Chi

Sponsor: Defense Mapping Agency

Data compression is a method of reducing a given set of information to a more compact format. Data compression is often used in computer systems to reduce storage space needs, to decrease data transfer time, to decrease error occurrences, or to provide a level of security due to a reduced detec-

tion level. Image data compression techniques which make use of chaos and fractals have achieved compression ratios as high as 2500 to 1. The purpose of this research is to investigate the feasibility of applying fractal compression methods to geographical maps and textual data.

### **Designing a OO-Database for an Integrated Shiphull Form Design, Analysis, and Evaluation System**

Researcher: Assistant Professor Nikolaos Glinos

Sponsor: Naval Academy Research Council (ONR)

The design of an artifact, in general, is an excellent paradigm for applying object-oriented methods as well as artificial intelligence techniques. Artificial intelligence and expert systems have been used very little to provide high-level intellectual assistance to the ship designer. In particular, ship design could greatly benefit from those disciplines. Object-oriented design offers several advantages over the more traditional procedure-oriented design of a complicated system. Object-oriented systems promote rapid prototyping, reusability, and extensibility.

An object-oriented database containing ship design data, based on international standards as much as possible, could be used as the central module of an integrated shiphull form design analysis and evaluation system. Such an object-oriented database system is a natural choice for the representation of marine forms, and could also aid the incorporation of artificial intelligence methods to help the designer. The design of such an object-oriented ship design database is examined in this research.

### **Design and Validation of Expert Systems**

Researcher: Professor Patrick R. Harrison

Sponsor: Naval Research Laboratory, Code 5510

The author has been investigating validation issues for several years. Harrison (1989) and Harrison, et al. (1991) summarizes this work. The guiding assumption is that validation is not a separate process that follows development; validation is a process that is an integral part of design. Prototyping by its very nature involves continual validation as one basis for shaping the evolving system. The validation concept for a system grows and matures as does the design. The author has adopted the phase "adaptive design" to refer to design activities that abide by this philosophy.

This year was the beginning of the process of building a validation-based hybrid development environment. A hybrid development environment is defined as a set of integrated tools for knowledge-based systems (KBS) development that includes facilities for object definition, inheritance, object-oriented design, interface design, and a variety of engines that support symbolic reasoning. A validation-based, hybrid development environment would be a hybrid environment that has integrated validation concepts into the structure of the hybrid environment so that all phases of design would have

to consider validation concepts. The result would be a development environment that encourages adaptive design.

Tasks completed include: (1) definition of a GOAL FRAME that would provide a schema for a generic validation object or generic validation components associated with any object; (2) choice of a generic problem domain; (3) definition of classes of measurement operations that might be useful in operationizing the goal frame concept; and

(4) defining a means for KBS goal decomposition. This latter was accomplished by replacing the term goal with task, and then using Clancey's (1985) heuristic classification scheme as a mechanism for decomposing KBS into more workable components. Finally, the researcher accomplished evaluation of existing hybrid environments to define a platform for the implementation of the initial prototype of the adaptive design concept.

### **Implementation of a Parallel Solving Method for Linearly Constrained Concave Global Optimization Problems Using Parallel Computing**

Researcher: Midshipman 1/C Matthew F. McLaughlin, USN

Adviser: Assistant Professor Andrew T. Phillips

Sponsor: Trident Scholar Program

The goal of this research is to develop an efficient algorithm for finding the minimum value of a concave function constrained by linear boundaries. Central to all methods used to solve this problem is the fact that the global minimum occurs at a vertex of the constrained region. Previous methods have been deterministic, enumerating each vertex to find the solution. However, these approaches are not practical for problems with hundreds of dimensions and variables. The procedure considered in this project uses multiple trials, each involving a stochas-

tic method for finding a random vertex. The method proceeds from this vertex by using the function gradient to move down constraints until a local minimum is found. A stopping rule compares the number of unique local minima to the number of trials, and when satisfied, the global minimum will simply be the least of the local minima. The independent nature of each trial lends this approach to a parallel implementation on the Cray X-MP and Connection Machine CM-2 supercomputers.

# Independent Research

## A Pre-Calculus Intelligent Tutoring System

Researcher: Commander Charles A. Floyd, USN

Tutoring as a means of teaching has been shown to be much more effective than typical classroom situations. It is possible to develop Intelligent Tutoring Systems (ITS) that can be implemented via personal computer. By using a set of carefully developed "bugs," or common user errors for the subject domain, the ITS can elicit information about the student's current level of understanding of the subject being taught. This student model is then used to determine the lesson plan for a particular subject area. The ITS can provide the lessons, or if used in conjunction with a human tutor, it can provide a customized lesson plan to remediate defi-

cient knowledge areas.

The purpose of this ITS is to provide midshipmen with an aid to the mastery of pre-calculus concepts as necessary prerequisites for a freshman level calculus course. The system will have an intuitive, graphical user interface (GUI) and can be utilized by a midshipman with little or no additional assistance.

This project is in the early stages of research. Source material and software development tools are being evaluated, and informal discussions with domain experts (mathematics professors) are being conducted in an effort to develop a useful "bug" list.

## Computing Grobner Bases Over the Integers

Researcher: Assistant Professor Nikolaos Glinos

Grobner Bases is a valuable tool for examining and studying polynomial ideals. While there are several implementations of algorithms to compute Grobner Bases of Polynomial Ideals over a field, this is not true for Grobner Bases of Polynomial Ideals over the Integers  $\mathbb{Z}$ . The researcher is implementing such an algorithm using the computer algebra lan-

guage MATHEMATICA. This program will be used to compute Grobner Bases of Integer Polynomial Ideals of interest to algebraic topologists. Methods for the primary decompositions of finitely generated polynomial ideals can then be implemented in order to examine and categorize such ideals in algebraic topology.

## Elementary First Integrals of First Order Non-Linear Differential Equations

Researcher: Assistant Professor Nikolaos Glinos

A first integral of a system of differential equations is a function which is constant on solution curves. If it can be expressed in terms of exponential, logarithmic, and algebraic functions, then it is called elementary. An elementary integral provides an implicit solution at the system. In this research the investigator uses the Prelle-Singer method for computing elementary first integrals of first order

nonlinear ordinary differential equations. The method is also extended to differential equations with transcendental coefficients. The method has been implemented in MACSYMA and will also be implemented in MAPLE and MATHEMATICAL. Part of this research is to study the efficiency of this method.

## **Using Operational Calculus and First Integrals to Solve Inclosed Form, nth Order Ode's**

Researcher: Assistant Professor Nikolaos Glinos

In this work, the researcher examines the use of operational calculus and first integrals of differential equations to solve high order ( $>2$ ) equations. Operational calculus methods can be used to reduce the order of the differential equation and transform it to a lower order one. The method of elementary

first integrals can be used to solve this new equation. An inverse transformation is then needed to obtain the solution of the original equation. Part of this research is to identify classes of differential equations (higher order) for which this method can be formulized.

## **Mapping Precedence Trees to Generalized Hypercubes and Meshes**

Researcher: Visiting Professor Stuart G. Ullman

This project considers methods to assign the modules of a task precedence graph to the CPU's in a distributed memory, message passing network of processors with fixed topology and limited size. The research uses the precedence partial ordering on the task modules to minimize the cost of the contrac-

tion and mapping of the task graph. As a specific example, this project uses the mapping of arbitrary trees to generalized hypercubes and meshes. The research is done in cooperation with Professor B. Narahari of George Washington University.

## **A Graph Coloring Interpretation of Proper Partitions of Task Precedence Graphs**

Researcher: Visiting Professor Stuart G. Ullman and  
Associate Professor Carol Crawford (Mathematics)

This research considers the partition of a set of task modules which taken together, form a larger task, and which are partially ordered by precedence relations among the modules, into subsets each totally ordered by the restriction of the precedence partial ordering to the subset. It is initially shown that this problem may be stated as a graph vertex coloring problem. A method of properly partitioning arbitrary trees has been accomplished.

Current research will attempt both to extend the earlier project to offer methods of contracting more general graphs, and to provide some general properties of such partitions. For example, some bounds on the cardinality of the minimum proper partition of particular task precedence graphs may be drawn from similar bounds on the chromatic number of a graph derived from it.

## Publications

GLINOS, Nikolaos, Assistant Professor, "Computer Algebra and Desuspensions of Stunted Real Projective Spaces," *International Journal of Computer Mathematics*, 41, 3&4 (1992), 11-20.

In this work the author applies computer algebra methods to partially solve a geometric problem which arises in algebraic topology. This is related to a particularly interesting formal power series, the [2]-series. Although original motivation stems from topology, the problems can be defined in a purely combinatorial way to indicate its usefulness. The problem in its general form is a long standing conjecture. This article extends results by Bendersky-Davis and Wilson by several dimensions.

GLINOS, Nikolaos, Assistant Professor, "Ship Design: An Object-Oriented Paradigm, *Proceedings of the Conference on Computer Applications in Design, Simulation, and Analysis*. International Society on Mini and Microcomputers, Orlando, Florida, 11-13 March 1992, pp. 147-150.

Ship design is a complicated and time-consuming process which is currently receiving considerable attention. The design of an artifact is generally an excellent paradigm for applying Object-oriented (OO) methods as well as Artificial Intelligence (AI) techniques. Ship design in particular could greatly benefit from those disciplines. OO design offers several advantages over the more traditional procedure-oriented design of a complicated system. OO systems promote rapid prototyping, reusability, and extensibility. This paper briefly surveys the ship design problem, describes the OO design methodology, and examines the application of the OO paradigm to the ship design area.

GLINOS, Nikolaos, Assistant Professor, and Bruce JOHNSON, Professor (Naval Systems Engineering), "A Review of Expert Systems for Marine Design and Ship Operations," *Proceedings of the Conference of the World Congress on Expert Systems*, Orlando, Florida, 16-19 December 1991, pp. 3055-3063.

Marine design refers to many aspects of designing ships and structures for operation in the marine environment. For example, the conceptual design of ship hull forms involves investigating the effects of hull geometry variations on hydrodynamic performance characteristics in still water and in waves. On the other hand, ocean structures are designed to withstand severe wave conditions, so the resistance in still water is of little importance. Ship

operations refer to all aspects of ocean shipping, including cargo handling, piloting and routing, as well as machinery operation and maintenance. The application of artificial intelligence techniques and ideas has so far been more common in ship operations than in ship design. Most of the work done in computer-aided ship design has been on the analysis and evaluation of candidate designs. Expert systems have been used very little to provide high-level intellectual assistance to the generation of possible design solutions and to control the design process. Some attempts to develop integrated CAD systems for ship design and construction are underway, and artificial intelligence methods are seriously being considered in several of these projects.

HARRISON, Patrick R., Professor, co-author, "Learning Class Descriptions from a Database of Spectral Reflectance with Multiple View Angles," *IEEE Transactions Geosci & Remote Sensing*, (1992), pp. 315-325.

The purpose of this paper is to describe the development and implementation a discrimination learning algorithm that could learn class descriptions of one or more vegetation classes. This algorithm was integrated into an existing Expert System called VEG. The research demonstrated that the system could learn new class descriptions without human intervention and use them to classify unknown targets.

HARRISON, Patrick R., Professor, co-author, "A Knowledge-Based Expert System for Inferring Vegetation Characteristics," *International Journal of Remote Sensing* 12, 10 (1991), 1987-2020.

VEG is an Expert System that implements a robust extraction technique for inferring physical and biological surface properties of vegetation using nadir and/or directional reflectance data as input. VEG accepts spectral data of an unknown target as input, determines the best strategy or strategies for inferring hemispherical reflectance, applies the strategy or strategies to the target data, and provides a rigorous estimate of the accuracy of the inference. VEG is also intended to become a valuable research tool with provisions for testing and developing new extraction techniques, for browsing and analysis of the system databases, and for the development of discrimination learning algorithms that discriminate the spectral and directional reflectance relationships between user-defined vegetation classes.

HARRISON, Patrick R., Professor, co-author, "The Validation of Embedded Knowledge-Based Systems, *Proceedings of the Twenty-second Annual Pittsburgh Conference on Modeling and Simulation*, 1981, pp. 796-802.

This paper introduces a model for the development and validation of intelligent control problems. The figure shows a very abstract data flow through the system and its transformation via inductive or deductive processes. The basic flow is:

SENSE DATA--induction--> MODEL  
FORMATION--deduction--> WORLD  
STATE ESTIMATES--deduction--> CONTROL  
ACTION ASSIGNMENT

Several things are important about this flow. First, models are induced from sensor data. Since more than one model can account for a sensor state, it would be more accurate to state that implicitly classes of models are induced from sensor data. Using the formed model (s) and a data structure representing world state, a world state estimate is deduced. The world state estimate is time synchronized and is time sampled. Ideally, world state should be sufficient for deducing control action. World state includes everything necessary for the decision logic to recommend the next control action.

In this model, the decision control component can view the world state as sufficient for the definition of an action assignment. Given this, the validation problem is more tractable. This is because the temporal data management problem is removed at the deduction point. If the flow in the figure is considered from the validation view, it should be apparent that lack of predictive validity in terms of expected versus observed control action recommendations can be attributed to either model errors or deductive logic errors or to both.

PARK, Eun Kyo, Associate Professor, "Hybrid-token Ring: A Load- Sharing Local Area Network," *Journal of Computer Communications*, 14, 9 (November 1991), 525-533.

A load-sharing network, hybrid-token ring, which can connect computers and communicating devices for real-time and/or interactive applications, is presented. The hybrid-token ring has a dual channel structure, a token ring, and a data channel. The token ring is a modification of ANSI/IEEE LAN standard 802.5. The data channel is a collection of full-duplex data links. With this architecture, an insertion of direct data links not only allows real-time and/or interactive communication between node pairs, but also improves overall network performance in a token ring. A medium access control (MAC) protocol for the network is

developed, and specifications for the MAC layer are described. Also a finite state machine for data link channel interface is devised. A simulation model has been developed to measure a performance improvement of hybrid-token ring over a pure token ring. Simulation results indicate that a small increase in link cost for data links can greatly improve performance over a pure token ring before the insertion of the data links.

PARK, Eun Kyo, Associate Professor, "Minimizing the Communication Cost of Updating Data-items in Replicated Databases on a Hypercube Using the Multicast Policy," *Proceedings of International Conference Computer Communications and Networks (IC3N)*, San Diego, California, 8-10 June 1992, pp. 315-320.

Distributed database systems consist of a number of nodes which are connected by a communication network. The data objects are partially replicated to improve availability and performance. Partially replicated databases present a number of design considerations, such as the number of copies, the placement of copies, and the degree of replication. In this paper the author considers only optimal replication scheme of data objects; i.e., at which processors in the network the replicas should be located.

Simulation of a partially replicated database running on a hypercube is used to analyze placements of replicated data objects. The simulation study focuses on placement of data items from the communication cost point of view; i.e., in terms of message complexity. In replicated databases the number of messages required to propagate updates to copies has to be minimized. The minimum spanning tree write, by which a processor on a hypercube should multicast a write of a data item, to all processors that store replicas of the item is shown to be optimal from the communication cost point of view. An efficient multicast policy provides message delivery to a group of processors at a lower network and processor overhead than broadcasting to all processor or unicasting to each processor in a group.

PARK, Eun Kyo, Associate Professor, "An Approach to Distributed Systems Recovery and Fault Tolerance," *Proceedings of International Conference on Computer Applications in Design, Simulation and Analysis*, Orlando, Florida, 11-13 March 1992, pp. 123-125.

Here the author addresses the problem of recovering from transient failures in a distributed system by bringing the system to a consistent restarting point using the methods of rollback and consistent states. First, he describes the type of

distributed system to be studied, addressing a system with shared memory and a synchronization scheme as the communication network among processes. Next, he develops the necessary criteria for a consistent state to be achieved in such a system, assuming that two consistent states will have to be saved on nonvolatile storage. Then he develops a modified algorithm for rollback, based on previous algorithms developed in the works cited (1,3,11), and tailored specifically to this type of distributed system and assumptions. In addition the algorithm will not address failures that occur during the execution of the rollback algorithm. This is not considered troubling, because these types of errors can be masked and handled at a later time by using existing language facilities.

PARK, Eun Kyo, Associate Professor, "Expert System Support for Hybrid-Ethernet Configuration Design," *Proceedings of International Conference on Engineering and Industrial Applications*, Long Beach, California, 16-18 December 1991, pp. 67-70.

Hybrid-Ethernet has been introduced to overcome the shortcomings of Ethernet which include: lack of guaranteed private and secure communication; difficulty in establishing interactive communication; difficulty in upgrading the performance to accommodate increased system load, etc. The Hybrid-Ethernet is implemented by adding an additional channel (data links channel) to the conventional Ethernet. Data links may be inserted/removed on a running network between pairs of nodes to accommodate frequent communication, secure/interactive communications based on specific communication characteristics, or changes in the application environment. With this architecture a LAN can be installed in the form of Ethernet and may be upgraded and tuned to its application environment by the insertion of node-to-node data links. This paper discusses the development of an Expert System enabling a user to decide where to insert the data links in order to design the most desirable network configuration. The decision will be based on factors such as traffic load, network performance, network capabilities, users' requirements, etc.

PARK, Eun Kyo, Associate Professor, "End-to-End Delay of Interconnected Local Area Networks," *Proceedings of International Conference on Parallel and Distributed Computing and Systems*, Washington, DC, 8-11 October 1991, pp. 15-19.

A simulation model for the interconnected local area networks (LAN's) is presented in this paper. The interconnected networks consist of token ring, fiber-distributed data interface (FDDI) network, and carrier sense multiple access with collision detection (CSMA/CD) network. In the intercon-

nected networks, the local users on the token ring send intra- or inter-network packets. The inter-network packets are transmitted to CSMA/CD network via gateways and FDDI network. In the meantime, the local users on the CSMA/CD network generate intra-network packets. The model focuses on the end-to-end delay between two end users on token ring and CSMA/CD network.

PARK, Eun Kyo, Associate Professor, "The Structured Prototyping Life Cycle Model for Systems," *Proceedings of IEEE/ACM Joint Conference on Expert Systems*, Washington, DC, 30 September-2 October 1991, pp. 267-272.

There are many different methodologies and models for the concept of a project life cycle for software and knowledge engineering applications. These methodologies range from radical (all activities take place in parallel) to conservative (one activity is finished to completion before the next is started). By combining methodologies that come from both ends of this spectrum, a new methodology that contains the best aspects of each can be produced. The structured project life cycle is a methodology that is moderately conservative. The prototyping life cycle is a methodology that is radical. By combining these methodologies a new life cycle called the structured prototype life cycle is produced. This new methodology combines the rigor of the structured approach with the flexibility and quick production of results from prototyping. The new methodology can be considered a conservatively radical life cycle.

PHILLIPS, Andrew T., Assistant Professor, co-author, "A Parallel Stochastic Method for Solving Linearly Constrained Concave Global Minimization Problems," *Journal of Global Optimization*, 2 (1992), 243-258.

A parallel stochastic algorithm is presented for solving the linearly constrained concave global minimization problem. The algorithm is a multistart method and makes use of a bayesian stopping rule to identify the global minimum with high probability. Computational results are presented for more than 200 problems on a Cray X-MP EA/464 supercomputer.

PHILLIPS, Andrew T., Assistant Professor, co-author, "Global Optimization of Quadratic Fractional Programs," *Journal of Global Optimization* 1, 2 (1991), 173-182.

Dinkelbach's global optimization approach for finding the global maximum of the fractional programming problem is discussed. Based on this idea, a modified algorithm is presented which provides both upper and lower bounds at each

iteration. The convergence of the lower and upper bounds to the global maximum function value is shown to be superlinear. In addition, the special case of fractional programming when the ratio involves only linear or quadratic terms is considered. In this case, the algorithm is guaranteed to find the global maximum to within any specified tolerance, regardless of the definiteness of the quadratic form.

PHILLIPS, Andrew T., Assistant Professor, co-author, "Sufficient Conditions for Fast Solution of Linearly Constrained Concave Global Minimization Problems: Computational Implementation," Army High Performance Computing Research Center Preprint 91-66. Minneapolis, Minnesota: University of Minnesota, pp. 1-16.

Sufficient conditions are presented which, if satisfied, guarantee that the solution to a single linear program also solves the linear constrained concave global minimization problem. Based on a simple geometric argument, as well as on previous computational experience, it seems reasonable to expect that the global minimum of a purely concave minimization problem can be obtained by solving a single linear program; that is, whenever the linear terms "dominate" the concave terms on the polytope. An algorithm which implements these conditions and is guaranteed to find a global optimum function value (with its corresponding vertex) to within any specified tolerance is also presented.

PHILLIPS, Andrew T., Assistant Professor, "A Separable Quadratic Global Minimization Formulation of the Linear Complementarity Problem." USNA Computer Science Department Report, November 1989.

The Linear Complementarity Problem (LCP) is formulated as a linearly constrained separable concave quadratic global minimization problem, which is independent of the properties of the Matrix  $M$ .

PHILLIPS, Andrew T., Assistant Professor, "A Characterization of the Global Minimizer of a Linearly Constrained Indefinite Quadratic Minimization Problem." USNA Computer Science Department Report, January 1989.

The global minimum point  $x^*$  of an indefinite quadratic function  $f(x)$  defined over a bounded polyhedral set is considered. It is shown that if the Hessian of  $f(x)$  has  $j$  non-negative eigenvalues, then  $x^*$  must lie to a  $k$ -face of for some  $k < j$ .

SCHULZE, Kay G., Associate Professor, and J.J. SPEGELE, Major, USMC, "Advantages and Problems of a Computer-rich Educational Environment," *The Journal of Computing in Small Colleges*, 7, 3 (Winter 1992), 153-163.

The United States Naval Academy is a unique university of medium size with the highest student-to-computer ratio of any university in the country. While other universities suffer from a lack of facilities, the Academy's status as a well-funded, well-equipped university does not come without a unique set of problems. This paper discusses a variety of advantages and pitfalls associated with the integration and use of computer systems in a university setting. In particular, the authors address and make recommendation in the following critical areas: standardization of student machines; integration of dissimilar hardware/software; faculty and student training; and installation and maintenance of a campus network.

SCHULZE, Kay G., Associate Professor, co-author, "Comparing Three Numbers: The Effect of Number of Digits, Range, and Leading Zeros," *Bulletin of the Psychonomic Society* 29, 4 (July 1991), 361-364.

The literature is abundant with results on the cognitive processes involved in determining the larger of two numbers. In the present experiment, range, number of digits, and leading zeros were varied to determine whether some of the major results for comparing two numbers generalize to judgements of the largest of three numbers. There were consistencies as well as inconsistencies between the results and previous two-number comparison data. For example, the distance effect (Moyer & Landauer, 1967) held for three-digit numbers but was not replicated for single-digit numbers. A two-stage process is suggested, with an encoding stage and a comparison stage. At the comparison stage, strategies may vary, depending on the nature of the comparison that is to be made.



SCHULZE, Kay G., Associate Professor, "Assessment of an Error Reduction Tool in the Transformation of Algebraic Word Problems into Equivalent Equations," USNA Computer Science Report TR-91-3, 1991.

The major purpose of this study was to determine if an intelligent tutoring system can improve a student's ability to transform an algebraic word problem involving two unknowns from its natural language representation into its equivalent abstract algebraic equation. The study was a pretest/post-

test design involving three problem classifications; the results were analyzed using a one-tailed, paired t-test ( $\alpha = .05$  and  $df = 16$ ). A second purpose of the study was to determine if the system enabled the student to generalize the knowledge acquired in solving one classification of problems to the other two classifications. The final purpose was to determine whether there exists a relationship between the amount of explicit, requisite information contained in the problem and the difficulty of the problem.



## **Presentations**

GLINOS, Nikolaos, Assistant Professor, "Solving ODE's Using MACSYMA," Workshop on Symbolic Astrodynamics by Computer," co-sponsored by the National Capital Section, AIAA, U.S. Naval Academy, Annapolis, Maryland, 5-9 August 1991.

GLINOS, Nikolaos, Assistant Professor, "An Introduction to Grobner Bases," Workshop on Symbolic Astrodynamics by Computer, co-sponsored by the National Capital Section, AIAA, U.S. Naval Academy, Annapolis, Maryland, 5-9 August 1991.

GLINOS, Nikolaos, Assistant Professor, "A Review of Expert Systems for Marine Design and Ship Operations," Conference of the World Congress on Expert Systems, Orlando, Florida, 15-16 December 1991.

GLINOS, Nikolaos, Assistant Professor, session chairman, "Ship Design and Expert Systems," World Congress on Expert Systems Conference, Orlando, Florida, 16-19 December 1991.

GLINOS, Nikolaos, Assistant Professor, "Ship Design: An Object-Oriented Paradigm," Conference on Computer Applications in Design, Simulation, and Analysis, International Society on Mini and Microcomputers, Orlando, Florida, 11-13 March 1992.

GLINOS, Nikolaos, Assistant Professor, session chairman, "Modeling Issues in Artificial Intelligence and Simulation," Artificial Intelligence and Simulation Conference, New Orleans, Louisiana, 1-5 April 1991.

HARRISON, Patrick, Professor, "Using ADA in Teaching Data Structures," Sixth Annual ADA Software Engineering Education and Training Symposium, Institute for Defense Analyses, Alexandria, Virginia, 12 September 1991.

HARRISON, Patrick, Professor, "Knowledge-Based Ship Design Aids: A Passive Fire Protection Example," World Congress on Expert Systems, Orlando, Florida, 19 December 1991.

HARRISON, P., Professor, panelist, "Expert Systems and Ship Design," World Congress on Expert Systems, Orlando, Florida, 19 December 1991.

HARRISON, Patrick, Professor, "Intelligent Sensor Control on the F-14D Aircraft," U.S. Army Test and

Evaluation Command Artificial Intelligence Conference, Fort Huachuca, Arizona, 15 January 1992.

HARRISON, Patrick, Professor, chair of workshop, "Artificial Intelligence Tools & Methodologies for Operational Test & Evaluation Applications," Center for Applied Research in Artificial Intelligence, Naval Research Laboratory, Washington, DC, 7 February 1992.

HARRISON, Patrick, Professor, "Intelligent Real-Time Sensor Control," Twenty-third Annual Pittsburgh Conference of Modeling and Simulation, Pittsburgh, Pennsylvania, 1 May 1992.

HARRISON, Patrick, Professor, panelist, "Are Not Reports of Model Perscrutation + Confirmation Required?," Twenty-third Annual Pittsburgh Conference of Modeling and Simulation, Pittsburgh, Pennsylvania, 1 May 1992.

HARRISON, Patrick, Professor, "New Developments of a Knowledge-Based System (VEG) for Inferring Vegetation Characteristics," International Geoscience and Remote Sensing Symposium, Houston, Texas, 26-29 May 1992.

PARK, Eun K., Associate Professor, "The Structured Prototyping Life Cycle Model for Systems Development Management," IEEE/ACM Conference on Expert Systems, Washington, DC, 2 October 1991.

PARK, Eun K., Associate Professor, "End-to-End Delay of Interconnected LAN," International Conference on Parallel and Distributed Systems, Washington, DC, 8-11 October 1991.

PARK, Eun K., Associate Professor, "Translating Petri-Net Model of Real-Time Systems to ADA," Johns Hopkins University, Space Telescope Science Institute, Baltimore, Maryland, 5 November 1991.

PARK, Eun K., Associate Professor, "Translating Petri-Net Model to ADA Programs: An Automation," University of Maryland, College Park, Maryland, 6 November 1991.

PARK, Eun K., Associate Professor, "An Approach to Distributed Systems Recovery and Fault Tolerance," International Conference on Design, Analysis, and Simulation, Orlando, Florida, 11-13 March 1992.

PARK, Eun K., Associate Professor, "Hybrid Architecture of LANS," IEEE Communication and Networks Conference, Phoenix, Arizona, 1-3 April 1992.

PARK, Eun K., Associate Professor, "Minimizing the Communication Cost of Updating Data-Items in Replicated Databases on a Hypercube Using the Multicast Policy," IC<sup>3</sup>N Conference, San Diego, California, 8 June 1992.

PHILLIPS, Andrew, Assistant Professor, "Sufficient Conditions for Fast Solution of Linearly Constrained Concave Global Minimization Problems," Army High Performance Computing Research Center, Minneapolis, Minnesota, 10 July 1991.

PHILLIPS, Andrew, Assistant Professor, "Sufficient Conditions for Linearly Constrained Concave Global Minimization: Computational Implementation," The Fourteenth International

Symposium on Mathematical Programming, University of Amsterdam, Amsterdam, The Netherlands, 9 August 1991.

PHILLIPS, Andrew, Assistant Professor, "Computational Comparison of Two Methods for Constrained Global Optimization," ORSA/TIMS Joint National Meeting, Orlando, Florida, 27 April 1992.

PHILLIPS, Andrew, Assistant Professor, "Computational Comparison of Two Methods for Constrained Global Optimization," SIAM Conference on Optimization, Chicago, Illinois, 11 May 1992.

SCHULZE, Kay, Associate Professor, "Advantages and Problems of a Computer-rich Education Environment," Southeastern Small College Computing Conference, Nashville, Tennessee, 1-2 November 1991.



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# Mathematics

Professor James M. D'Archangelo  
Chair

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**M**athematics provides a logical framework and a language indispensable to understanding the world in which we live. The following pages summarize the many contributions to this field of study made during the past year by the faculty and students of the Naval Academy. The results cited reveal the great scope and diversity of mathematics and offer glimpses of its intellectual beauty and appeal.

This past academic year was a very productive one for the faculty. Over forty research articles appeared in refereed journals published throughout the United States and abroad. The topics covered in these articles are as varied as mathematics itself. They range from the "applied" areas of submarine detection, automated fingerprint identification, the buckling of rods, and the fracturing of ice formations, to the "pure" areas of harmonic functions,  $C^*$ -algebras, and number theory.

Over fifty research projects were conducted by members of the Mathematics Department with the support of a variety of sources such as the National Science Foundation, the Johns Hopkins University Applied Physics Laboratory, the David Taylor Research Center, the Naval Academy Research Council, the Naval Academy Instructional Development Advisory Committee, the NASA Goddard Space Flight Center and Robotics Laboratory, the American Mathematics Society, the Office of the Chief of Naval Research, the American Society for Engineering Education, the Federal Bureau of Investigation, the Los Alamos National Laboratory, and the Office of Naval Technology.

During the past year, department members presented the results of their work on eighty-six



different occasions at professional mathematical meetings and colloquia throughout the United States and abroad. This activity, along with publication, enhances the academic stature of the Naval Academy and promotes the professional growth and reputation of those individuals involved. Through research activity, the faculty learn of and take part in the discovery of new mathematics. New material and ideas can then be shared with midshipmen in advanced courses.

## **Sponsored Research**

### **A Teaching Package for Numerical Methods and Analysis**

Researchers: Professor James L. Buchanan and

Associate Professor Peter R. Turner

Sponsor: Naval Academy Instructional Development Advisory Committee

There is at present no suitable published course material for the various numerical analysis courses (SM364, SM425, and SM426) which is appropriate for the Turbo PASCAL environment. The main aim of this work is to produce course materials -- notes, numerical algorithm code and software, and graphics support. A secondary purpose is to identify those areas of numerical mathematics which are most appropriate for practical treatment in introductory courses in scientific computation for presentation to other technical majors. This may well become a pressing need after the core courses review takes effect.

Over the last several years the methods of computer solution of the mathematical problems arising from modelling of physical situations have been steadily growing in importance. The range of problems which use scientific computation in their solution has grown along with the availability of computing power. However, the mathematical texts for the teaching of this material in undergraduate courses have remained firmly fixed in the use of FORTRAN as the primary programming language. The widespread--and, importantly, the local--use of Turbo PASCAL has been largely ignored thus far.

It is certainly not just coincidence that during this period of the simultaneous lack of appropriate teaching materials and the Naval Academy's computer revolution that the computer track of the Mathematics major has not been successful in attracting large numbers of able midshipmen into this important area. The development of good text, software, and support materials tailored to the needs of our students should be an influential step

in reversing this paucity of interest. The text material is being developed from the material currently covered in the courses and the supplementary notes already in use. The programs are written to take advantage of the new facilities offered by Turbo PASCAL Version 5.5, such as the ability to pass functions into and through procedures. It is the lack of this ability which has meant that even the existing good software (such as the Turbo PASCAL Numerical Methods Toolbox) is of little assistance, since it does not allow large realistic problems requiring the use of more than one of these procedures to be solved. This Toolbox consists of "finished programs," and so its use does not give any real idea of the considerations which go into the development of scientific software.

The programs the researchers are developing include some similarly polished work but will also include sample programs to help the midshipmen in their understanding of the development and construction of such. The researchers also intend that the final versions will be sufficiently well-organized to be used as procedures within more extensive programs. By the end of the two courses students should have a good understanding of the broad aspects of the subject, together with useful experience in building complex programs to solve real-life problems using the basic programs as significant building blocks. Currently some 800 pages of text and several of the Turbo Pascal units are available for use within mathematics courses. They have been used as the primary text in SM425 and SM426 and as supplementary notes for SM364.

### **Self-Help Tutorials in Probability and Statistics**

Researcher: Professor Michael W. Chamberlain

Sponsor: Naval Academy Instructional Development Advisory Committee

The primary goal of this project is to produce stand-alone computer lessons for midshipmen to use as supplements to course work in probability and statistics. The lessons cover basic notions of elementary probability theory. Each lesson is

designed to emphasize a certain aspect of this theory and to give the student a better feeling for what randomness is and how mathematics attempts to model nondeterministic phenomena. In particular, elementary simulations are used to show

how well the theory predicts reality.

Recent work has been directed toward providing the user more opportunities for interactive experimentation. One program was refined to allow the user easily and quickly to simulate random "games." This means that solutions to fairly complicated problems can be approximated through repetition. Also, theoretically derived answers can

be checked for accuracy. A large tutorial was produced to demonstrate what mean and standard deviation do and do not mean through an investigation of several versions of the classical "matching game." Six pages of computer problems were assembled for the SM239 Lesson Assignment Sheet.

## **Relaxation Algorithms for Automated Fingerprint Identification for the Federal Bureau of Investigation**

Researcher: Associate Professor Carol G. Crawford

Sponsor: Federal Bureau of Investigation

The major goal of this ongoing research project has been the development of innovative and alternative mathematical methods of artificial intelligence applicable to automated fingerprint identification. This investigation was a cooperative project with Dr. Eric Mjolsness, Yale University, Computer Science Center. Together, the investigators developed methods utilizing relaxation algorithms, including snakes and splines, Zucker's splines, elastic nets, smoothed local symmetries, and graph matching neural nets. These methods were then applied to

the specific problems in automated classification, matching and verification, as well as to problems in trainability, scalability, and robustness. The researchers received two letters of commendation from the FBI, including one from the Assistant Director, Lawrence K. York. The investigators will be continuing their work under an additional grant from the FBI. In addition, the investigation will be a cooperative effort with Yale University's newly-opened Center for Theoretical and Applied Neural Science.

## **Development and Analysis of a Numerical Method for Solving the Nonlinear Parabolic System Describing the Formation of Wing Cracks in Ice**

Researcher: Assistant Professor Sonia M. F. Garcia

Sponsor: Office of Naval Research

The main goal of this analysis is to monitor the growth of the temperature at the tip of the crack. It is expected that the stress intensity factor at the tip of the crack will contribute to a sharp rise in the temperature in a small neighborhood of the tip of the crack. Ultimately, it is expected that the phe-

nomenon of shear localization becomes the revealing deformation. It is also expected that the temperature behaves in such a way that in some instances the gradient of the velocity will blow up in finite time.

## **On the Smoothing Property of the Mixed Finite Element Method for Parabolic Equations**

Researcher: Assistant Professor Sonia M. F. Garcia

Sponsor: Naval Academy Research Council (ONR)

The researcher analyzes the mixed finite element approximation of the general second-order parabolic initial-boundary value problem. For the second-order continuous time method with initial data only in  $L^2$ , the researcher expects to prove that the method can do at least as good as the Galerkin

method, i.e., an  $L^2$  error estimate of order  $O(h^2/t)$ . Some results are expected to be shown for the error in negative Sobolev norms and for the time derivative of the error. The researcher expects to use only elementary energy techniques based on parabolic duality arguments.

## The P-version of the Mixed Finite Element Method for Non-Linear Parabolic Equations

Researcher: Assistant Professor Sonia M. F. Garcia  
Sponsor: Office of Naval Research

The researcher intends to investigate the behavior of the p-version of the mixed finite element method when applied to non-linear parabolic problems. The researcher wants to compare the performance of the mixed finite element method with quasi-uniform mesh with respect to the number of the

degrees of freedom, to determine whether the p-version will perform better than the h-version. The researcher believes that in the case where the solution has singularity of the type occurring in the corner of the domain, the rate of the p-version is twice that of the h-version.

## Stress-Energy-Momentum Tensors and the Belinfante-Rosenfeld Theorem

Researcher: Associate Professor Mark J. Gotay  
Sponsor: National Science Foundation

The researcher presents a new method of constructing a stress-energy-momentum tensor for a classical field theory based upon covariance considerations and Noether theory. The stress-energy-momentum tensor  $T_{\nu}^{\mu}$  is defined using the (multi)momentum map associated to the spacetime diffeomorphism group.  $T_{\nu}^{\mu}$  is uniquely determined as well as gauge-invariant, and depends only upon the divergence equivalence class of the

lagrangian. It satisfies a generalized version of the classical Belinfante-Rosenfeld formula, and hence *naturally* incorporates both the canonical stress-energy-momentum tensor and the "correction terms" which are necessary to make the latter well behaved. Furthermore, in the presence of a metric on spacetime, the researcher's  $T_{\nu}^{\mu}$  coincides with the Hilbert tensor and hence is automatically symmetric.

## On the Komar Mass in General Relativity

Researcher: Associate Professor Mark J. Gotay  
Sponsor: National Science Foundation

The researcher shows that the Komar mass in general relativity arises in a natural way as a component of the momentum map associated to the spacetime diffeomorphism group. Various impli-

cations of this fact are being developed and checked in the cases of electrovac and Schwarzschild solutions of the Einstein equations.

## $L_2$ -Cohomology of Poincare- and Saper-Type Metrics

Researcher: Assistant Professor Caroline G. Grant  
Sponsor: Naval Academy Research Council (ONR)

Over the last decade, great progress has been made in describing the structure of singular analytic spaces, using intersection cohomology and  $L_2$ -cohomology. Saper recently proved that these two types of cohomology are isomorphic for varieties with isolated singularities, provided that a complete Kahler metric with "distinguished growth" is used to compute the  $L_2$ -cohomology. Similar results have

been obtained by other researchers using incomplete induced metrics. The objective of this project was to generalize Saper's construction and investigate the relationships among three types of metrics: induced incomplete metrics coming from embeddings of  $X$  in Kahler manifolds, generalized Saper metrics, and Poincare metrics. The project involves joint work with Professor P. Milman of the

University of Toronto.

The authors proved that if  $X$  is any analytic subvariety of a compact Kahler manifold  $M$ , there exists a complete Kahler metric with modified Saper growth on the smooth part of  $X$ . Their construction is simple and explicit, and is valid for any subvariety of a compact Kahler manifold with no restriction on the type of singularities. Moreover, their metric is quasi-isometric to the sum of the incomplete metric induced from  $M$  and a metric with distinguished

growth, and is bounded above by a Poincare metric whose  $L_2$ -cohomology is isomorphic to the intersection cohomology of a desingularization of  $X$ .

The researcher has written a paper titled, "Metrics for Singular Algebraic Varieties," containing the results of this joint work and is waiting for final approval from the co-researcher before submitting it for publication, as they continue their work on the use of complete Kahler metrics to describe the structure of singular varieties.

## The 2- and 3-Regular Shalika Germs for $G_2$

Researcher: Assistant Professor W. David Joyner  
Sponsor: Naval Academy Research Council (ONR)

The author investigated the geometry of the unipotent orbits of  $G_2$  using the method of Tom Haks and Robert Langlands. The idea is to represent explicitly the Shalika germs as principal value integrals on the  $f$ -rational points of certain

divisors on the Igusa variety for  $G_2$ . The method combines resolution of singularities, results from algebraic groups, and the theory of unipotent classes.

## Classification of the Isometric Extensions of a Multidimensional Bernoulli Shift

Researcher: Assistant Professor Janet W. Kammeyer  
Sponsor: National Science Foundation

A multidimensional Bernoulli shift is an independent process given by a commutative  $\mathbb{Z}^n$  action on a Lebesgue probability space. An isometric extension of this base process is a skew product of the Bernoulli shift with the action of  $G$ , some group of isometries on a compact metric space. What may such an extension look like? In particular, when is such an extension itself a Bernoulli process? This research seeks to answer such questions.

The researcher investigated the structure of these isometric extensions and proved that if such an extension is weakly mixing, then it must be a  $\mathbb{Z}^n$ -Bernoulli shift. More to the point, any such

extension may be classified, both up to isomorphism and up to  $C$ -isomorphism, according to the algebraic structure of the group of isometries  $G$ . These results extend to the isometric extensions of  $\mathbb{R}^n$ -Bernoulli flows and  $\mathbb{Z}^n$ -Bernoulli processes of infinite entropy.

The method used in this investigation is known as a "nesting procedure." The method amounts to showing that certain distributions of names in the extension process are close in the  $d$ -metric, via successive  $d$ -matching. Those processes which permit such a "nesting procedure" to be carried out successfully are exactly those which are Bernoulli.

## Structure Matrices in Combinatorics

Researcher: Assistant Professor T. S. Michael  
Sponsor: Naval Academy Research Council (ONR)

Structure matrices were introduced by Fulkerson and Ryser in the 1960's to study the combinatorial properties of classes of rectangular matrices of 0's and 1's. Recently, structure matrices were

introduced for classes of symmetric matrices. Early results indicate that there might be a parallel theory in the new setting. In particular, the fundamental existence theorem and the matching theorem of



Ryser have analogues in the new, symmetric setting.

The objective of this project was to generalize the classical theory of structure matrices and to find further analogues of the classical theory in a symmetric setting. The generalized existence conjecture was proved, but turned out to be of limited usefulness. In any application an existence theorem must be used in tandem with a result that characterizes substructures in terms of the degrees of the vertices of graphs; few results of this latter type are known. Two interesting analogues of the Ryser-Fulkerson  $\alpha$ -width formula from the classical theory were found in the new, symmetric setting. These formulas gave expressions involving structure constants for the minimum domination number among all directed graphs with a prescribed degree sequence. The theorems are a breakthrough in the

relatively new field of graph domination. Tangentially related results were obtained concerning graph decompositions. These results do not involve structure constants, but do reveal the intricacy of problems in which substructures are prescribed.

Deeper generalizations of the classical theory of structure matrices have been discovered, but will be of limited use until further related results involving substructures are proved. Future work in structure matrices will include developing a fuller understanding of the above-mentioned formulas for domination numbers in directed and ordinary graphs. These formulas were obtained via network flows. Direct proofs using matrix manipulation will presumably provide more insight into the behavior of domination numbers.

## Physical Processes in Spacetimes with Mild Singularities

Researcher: Associate Professor Deborah A. Konkowski

Sponsor: National Science Foundation

The researcher's purpose is to study the behavior of particles and fields in spacetimes which contain mild singularities. Theorems in general relativity predict singularities in large classes of spacetimes, but the nature of these singularities is mostly unknown. If mathematical tests prove a singularity is present in a spacetime, then it can be classified as one of three types depending on its strength: quasiregular, nonscalar curvature, or scalar curvature. The first

two types are mild.

The researcher is studying physical processes in spacetimes with quasiregular and nonscalar curvature singularities. In particular, the researcher is looking at cosmic strong spacetimes and colliding plane wave spacetimes. Even though these have mild singularities, they have unusual effects on particles and fields. The researcher plans further publication on this topic.

## Chain Addition Cycles

Researcher: Associate Professor Jody M. Lockhart

Sponsor: Naval Academy Research Council (ONR)

One technique employed in cryptography for producing a long sequence of digits from a short sequence of digits is called chain addition. Let  $m, n > 1$  be integers. The short sequence  $S = (s_1, \dots, s_n)$ , called the seed, is extended to  $S^* = (s_1, \dots, s_n, s_{n+1}, s_{n+2}, \dots)$ , where  $s_{n+k} = s_k + s_{k+1} \pmod{m}$ . Since  $Z_m$  is finite, it is clear that  $S^*$  must be periodic; denote its period by  $L(m, S)$ . Let  $L_n(m) = \max L(m, S)$ , where the maximum is taken over all  $n$ -tuples  $S$  of elements of  $Z_m$ . Paul Green and Pamela Liebeck investigated such chain addition cycles for  $n = 2$ .

One objective of this project was to determine which of the results of Green and Liebeck are true for arbitrary integers  $n > 2$ . In particular, the divisibility and submultiplicativity of  $L_n$  and the relationship between  $L_n(p)$  and  $L_n(p^k)$  for  $p$  prime

were investigated. Another goal was to construct an efficient algorithm to compute  $L_n(p)$  for primes  $p$ .

The questions about the length of the chain addition cycles were reduced to questions about periods of matrices. It was shown that the period of the companion matrix  $A$  of the polynomial  $f_n(x) = x^n - x - 1$  over  $Z_m$  is equal to submultiplicative, and a relationship between  $L_n(p^k)$  and  $L_n(p)$  was found. Some progress was made toward finding an algorithm for computing  $L_n(p)$ . By considering the prime factorization of  $f_n(x)$  into factors of degree  $d_1, \dots, d_r$  and by using the Primary Decomposition Theorem,  $L_n(p)$  was shown to be the least common multiple of  $\{L(B_1), L(B_2), \dots, L(B_r)\}$ , where  $L(B_k)$  divides  $p^{d_k} - 1$  if  $k > 1$ .

Most of the results of Green and Liebeck were extended from the  $n = 2$  case to the general case.

One question that remains unanswered is whether  $L_n(p^2)$  is ever equal to  $L_n(p)$ . A substantial part of

the work toward finding an efficient algorithm for computing  $L_n(p)$  has been accomplished.

## The Essential Spectra of Laplaceans

Researcher: Associate Professor Robert Lockhart  
Sponsor: Naval Academy Research Council (ONR)

This past year the researcher discovered an upper bound for the infimum of the essential spectrum of a Laplacean defined on a complete non-compact manifold. This improved previous work of Robert

Brooks. One of the consequences of the work is the proof of the fact that the set of Riemannian metrics that have 0 in their essential spectra is dense in the space of metrics.

## Stability, Bifurcation, and Fracture in Ice Mechanics

Researcher: Associate Professor Reza Malek-Madani  
Sponsor: Office of Naval Research

This proposal concerns three sets of partial differential equations that model the formation of wing cracks in ice, flow of ice-ocean fluid in the Arctic regions, and the influence of Arctic ocean internal wave packets on ice flexure.

The first set of differential equations will model a block of ice under uniaxial compression. Ice will be modelled as an anisotropic thermally conducting material with a nonlinear constitutive law. Using the three-dimensional formulation of the problem, the formation of wing cracks as a primary-secondary bifurcation problem will be established. The stability of wing cracks as equilibrium solutions of the governing equations will be one of the goals of this part of the proposal. Another goal of this work will be to compare the critical values of the loads that trigger the onset of wing crack formation with the available data of the experimental work of E. Schulson.

For the second set of equations the main points of concern are the existence of global weak solutions for the kind of nonlinearities that model

ice deformation as a compressible visco-plastic material. These equations of motion have been introduced by W. D. Hibler and have received some analytical and numerical treatments in the past. Because the flow is two dimensional, recent results on quasilinear parabolic systems will be used to extract the existence theorem. Then, in order to resolve a question concerning the localization of the flow near coastal boundaries, steady-state solutions of the system will be studied in a circular domain. The solutions will be cast as minimizers of proper nonlinear functionals, and their stability as solutions of the full dynamical system will be established.

The third set of equations was motivated by the experimental results of measurements of ice tilt during the Coordinated Eastern Arctic Experiment (CEAREX) and the ensuing discovery of internal waves on the Yermak plateau. The purpose of this part of the proposal is to develop a mathematical model for the experimental work and to prove the existence of solitary waves for this model.

## The Foundations of Continuum Mechanics and Untypical Problems

Researcher: Associate Professor Reza Malek-Madani  
Sponsor: National Science Foundation

The principal investigator, together with Associate Professor John F. Pierce of the U.S. Naval Academy and Clifford Truesdell of the Johns Hopkins University, continued their collaboration with Italian mathematicians in the group guided by Gianfranco Capriz of Pisa. Contacts with this group

were established during preceding visits made possible by the National Science Foundation U.S.-Italy program. They wish to develop and, if possible, complete the recent reorganization of the mathematical foundations of continuum mechanics so as to cover rigorously defined materials of grade

higher than one, including also the thermomechanics of such materials. The researchers will attempt to solve associated prob-

lems of topology, functional analysis, and geometric measure theory.

### Approximation Methods in Partial Differential Equations

Researcher: Professor Peter A. McCoy

Sponsor: Naval Academy Research Council (OMN)

Research was conducted at the Los Alamos National Laboratory on free boundary value problems with application to Hele-Shaw flows. While at the U.S. Naval Academy, a general polynomial expansion method was developed for locating the singularities of the analytic continuation of an analytic function. A method of constructing interpolating solutions that uniformly approximate was developed for a class of elliptic partial differ-

ential equations in several real variables. And, a method of identifying the optimal "polynomial" type approximation for solutions to the Helmholtz equation (in the plane) was developed in terms of the winding number of the error-curve. Current research is being conducted on free boundary value problems and on signal processing for band limited solutions for partial differential equations of higher order.

### On the Brown-Peterson Homology of Classifying Spaces

Researcher: Associate Professor George Nakos

Sponsor: Naval Academy Research Council (ONR)

This is a long-term project in which the researcher tries to compute the Brown-Peterson Homology of the finite abelian  $p$ -groups. This problem has essentially puzzled topologists since the 1960's. As the project continues, substantial progress has been made that has resulted in a series of publications. So far the researcher has successfully analyzed the

role of the  $[P^k]$ -series, and important information on its coefficients has had some applications. A sequence of ideals has been introduced that are properly contained in the ideals that annihilate the total class in the Bordism of the  $p$ -groups mentioned above.

### Computing Grobner Bases over $\mathbb{Z}$

Researchers: Associate Professor George Nakos and  
Assistant Professor Nickolas Glinos (Computer Science)

Sponsor: Naval Academy Research Council (ONR)

This project is the continuation of collaboration between the above researchers in computer algebra and algebraic topology. An implementation of Professor Buchberger's algorithm on the computation of Grobner Bases over  $\mathbb{Z}$  has been given. The program was written by using Mathematica. It has been successfully tested on

known examples from the literature. This program has already been applied in testing whether particular elements belong to certain ideals that arise naturally in algebraic topology. The researchers are currently writing a paper for publication reporting the implementation and the results so far. This project is very near completion.

## The Use of Computers in the Core Calculus Courses

Researchers: Professor Howard L. Penn and  
Assistant Professor Aaron I. Stucker

Sponsor: Naval Academy Instructional Development Advisory Committee

The purpose of the project is to investigate the use of computers in the teaching of calculus. There are a number of objectives in the use of computers in the teaching of calculus, the first of which is to help illustrate the concepts of calculus. A second objective is to stress the connection between the analytic and the graphical representation of functions and equations. Another objective is to present more interesting and realistic applications of the study of calculus. Above all, the ultimate objective is to make the students think about the mathematics rather than merely parrot a procedure.

The Naval Academy has purchased a site license for Microcalc, a well-respected program available for calculus. The researchers have also produced, with help from Professor James L. Buchanan, two programs, MPP and MPP3D, which are useful for the study of the subject. A collection of computer assignments covering the three semesters of calculus was also produced. Each student for the last several years has received a copy of the software for use in the calculus courses.

The programs and assignments are now used by almost all of the instructors teaching calculus. The collection of computer assignments do meet all of

the goals outlined above, and students are generally very receptive to their use. Naturally there are a few students who resist any effort to require them to think. In addition to its use at the Naval Academy, the researchers have received requests for over 600 copies of the programs and computer assignments from instructors at other universities, colleges and high schools, including six other countries. MPP has been favorably reviewed in the *College Mathematics Journal*, and there will be a review of MPP3D in the same journal within a year. The programs have been described in a number of workshops throughout the country on software for the teaching of mathematics. Since the program is public domain, there is no way to determine the number of faculty members and students who have used these programs. This is an ongoing project. MPP has been used for several years. MPP3D, which plots surfaces and curves in three space, was written a year ago. A new module was added to MPP which is used to present infinite series. The computer assignments have and are still being revised. Documentation for MPP3D needs to be written, and the computer assignments need to be revised.

## Algebras Associated with Shift Register Sequences

Researcher: Associate Professor Geoffrey L. Price  
Sponsor: National Science Foundation

A linear feedback shift register is a bit stream of 0's and 1's which is eventually periodic. These bit streams have proven useful in signal analysis, but they also have applications in the power series solutions to differential equations. In recent work the researcher has used bit streams to construct shift endomorphisms on a certain von Neumann algebra which occurs in the study of Quantum Statistical Mechanics. Two shift endomorphisms  $\alpha$ ,  $\beta$  are said to be outer conjugate if there is a unitary operator  $U$  in the algebra and an automorphism

$\gamma$ , such that  $\gamma \circ \beta = \text{Ad}(U) \circ \alpha \circ \gamma$ . In joint work with Robert Powers, the researcher has made extensive use of the computer to discover outer conjugacy invariants for shift endomorphisms. They have determined that there are connections between the bit streams and Bratelli Diagrams of weakly dense  $C^*$ -subalgebras, leading to outer conjugacy invariants. The researchers have used the computer as well to uncover some apparently new results about the rank of persymmetric matrices, which have been studied for over a hundred years.

## Spatial Extensions of Quasi-Free Derivations

Researcher: Associate Professor Geoffrey L. Price

Sponsor: National Science Foundation

A linear operator  $\delta$  defined on a uniformly dense  $*$ -subalgebra  $D(\delta)$  of a  $C^*$ -algebra  $B$  is called a  $*$ -derivation if it satisfies the Leibniz identity  $\delta(xy) = (\delta x)y + x(\delta y)$ , for all  $x$  and  $y$  in  $D(\delta)$ . It is said that  $\delta$  is a generator of a  $C^*$ -dynamical system if there is a strongly continuous semigroup  $\{\alpha_t; t \in \mathbb{R}^+\}$  of endomorphisms such that  $\delta$  is the infinitesimal generator (loosely speaking, the derivative with respect to  $t$ ) of  $\{\alpha_t\}$ . An interesting problem from both the physics and mathematics points of view is to obtain conditions which suffice for a derivation to admit an extension which is a generator of a  $C^*$ -dynamical system.

Quasi-free derivations on the CAR (canonical

anticommutation relations) algebra form a class of  $*$ -derivations for which the extension problem is extremely interesting. Quasi-free derivations are associated in a non-trivial way with symmetric operators on Hilbert spaces. A longstanding conjecture of R. T. Powers holds that a quasi-free derivation  $\delta_S$  associated with a symmetric operator  $S$  has a generator extension if and only if  $S$  has a self-adjoint extension and that these generator extensions of  $\delta_S$  are again quasi-free. Work in progress with Powers seems to indicate that the conjecture fails if one replaces the CAR algebra with  $B(5)$ , the weakly closed von Neumann algebra containing the CAR algebra.

## Digital Terrain Elevation Data (DTED) Map Program

Researcher: Professor Thomas J. Sanders

Sponsor: The Johns Hopkins University/Applied Physics Laboratory

The *Strike Warfare Effectiveness and Survivability Analysis System* (SWESAS) is a system that is being developed by the Strike and Anti-Surface Warfare Group of the Naval Warfare Analysis Department of the Johns Hopkins University Applied Physics Laboratory (APL). The purpose of this system is to aid an analyst in scenario development, scenario analysis, cruise missile survivability analysis, and cruise missile mission planning. During the summer of 1991, this investigator developed and wrote a program in the C language that may be used by an analyst to display and manipulate Digital Terrain Elevation Data (DTED) files. This program is

intended to become a part of SWESAS.

The DTED files are data files generated by the Defense Mapping Agency and are used in aspects of cruise missile mission planning. In particular, they are used by an analyst to assist in scenario analysis to investigate such things as radar site location and masking, and cruise missile flight paths. The DTED map program developed allows for computer-generated color displays of the (large) data files quickly, and allows the analyst to use the computer to determine radar site locations and masking, and to plan cruise missile flight paths.

## Electromagnetic Signature Reduction

Researcher: Professor John C. Turner

Sponsor: David Taylor Research Center, Annapolis Laboratory

Work is continuing on this classified project. A new set of sensors has been installed. Additional sea trials are scheduled for this fiscal year with the goal of extending the model to additional geographic

locations. Scale model work is also scheduled to allow further refinement of sensor placement. Collaborating on this research is P. Izat from the David Taylor Research Center.

## Implementation and Applications of Level-Index Arithmetic

Researcher: Associate Professor Peter R. Turner  
Sponsor: Naval Academy Research Council (ONR)

The proposal was to continue with the development of possible schemes for the eventual hardware implementation of LI arithmetic and the analysis of the algorithms used, while at the same time gaining more computational experience and evidence of the potential practical value of the system via applications using software implementations of the level-index, LI and symmetric level-index system. This system has the virtues of eliminating overflow and underflow and using a consistent and appropriate measure of precision throughout the range of the real numbers. The advantages are offset by the fact that arithmetic will be slowed down. However, the fact that the programmer or software designer would be freed from worries about potential overflow, and therefore from the need to scale problems, will in many cases more than balance this loss.

The principal objectives were to investigate further the implementation and application of LI and SLI arithmetic and the comparison of these with other proposed new computer arithmetics. Specifically, this has led to the publication of a paper in the *Proceedings* of the IEEE Symposium on Computer Arithmetic on the implementation and error analysis of extended arithmetic operations in SLI arithmetic. An expanded version of this paper is currently submitted to *IEEE Transactions on Computers*. A related paper co-authored with D. W. Lozier of the National Institute of Science and Technology is on reliable computation of vector norms in floating-point and SLI arithmetics. It has been accepted for publication in *Computing*.

Another paper with Lozier has just been finished. This begins the study of the use of SLI arithmetic within simulation and modeling, considering problems from turbulent combustion and data-fitting for compound exponential decays such as radioactive decay. A shortened version will be presented at the Twenty-third Pittsburgh Conference on Modeling and Simulation and will appear in the proceedings. The full paper is to be submitted to the *NIST Journal of Research*.

The methods of investigation included mathematical analysis, the development and use of algorithms for various arithmetic systems, and their application to the evaluation of mathematical functions. This included a comparative study of the various schemes. The study also included research into recent hardware design developments and their possible use in eventual implementations of the level-index scheme. The other major areas of activity here have been and are concerned with the use of parallel processors and the implications of the parallelism for the arithmetic system used.

The principal output of this research has been in the form of research papers and the development of ideas for further developments and publications. The work is still very much alive and is likely to be continuing for several more years. It is a major undertaking involving at least four principal active contributors. The new proposal is for continuation of this potentially very important line of research. The investigator also intends to discuss with Office of Naval Research in the near future the possibility of their funding work in this project.

## MNAP: Midshipmen Numerical Analysis Package

Researchers: Associate Professor Peter R. Turner and Professor James L. Buchanan  
Sponsor: Naval Academy Instructional Development Advisory Committee

The greatly increased use of computers in the academic program at U.S. Naval Academy has not, for the most part, been accompanied by student awareness of the power and methods of scientific computing. The Midshipmen Numerical Analysis Package (MNAP) will make available routines for solving the main problems of mathematics, science, and engineering using modern techniques of scientific computation. The package will be written in Turbo Pascal and will include numerical routines for iterative solution of (systems of) equations, polynomial, spline, rational and trigonometric

function (including FFT) interpolation and approximation, optimization, linear algebra, and the solution of (ordinary and partial) differential equations.

In the last several years the U.S. Naval Academy academic program has experienced its own computer revolution. This has resulted in several important software developments such as MPP and MDEP, which are extensively used in core courses and elsewhere for graphical demonstrations and exercises. The envisaged numerical methods package would add a natural third aspect by

concentrating on the numerical solution of mathematical problems.

During the last year much of the underlying programming has been completed. At this stage this comprises a group of Turbo Pascal units and individual programs which must be brought together for consistency and compatibility. One important consequence of no longer teaching all midshipmen to program is that this package should also be made available in a mouse-oriented menu-driven form. The new environment of Turbo Pascal version 6 will enable that to be done.

Over the last several years the methods of computer solution of the mathematical problems arising from modelling of physical situations have been steadily growing in importance. The range of problems which use scientific computation in their solution has grown along with the availability of computing power. However, there has been no easily accessible package of numerical software available to midshipmen and designed with their needs in mind.

The core curriculum review resulted in recommendations that, for example, less time should be spent on teaching techniques of inte-

gration since most of the simple examples can be found in tables or can be performed by calculators or software packages, while most of the realistic examples which arise in practical situations require numerical solution. In order to educate the midshipmen in this topic it is important that they are not simply presented with a "black box," but that they gain some understanding of the procedures involved. Similar comments apply to almost any situation in which computer solution of mathematical models is used. It is intended that MNAP should be accompanied with a "User manual" which will include brief outline descriptions of the methods and the types of problems for which they are suited, as well as warnings as to their limitations in order to counter the black box mentality.

The principal value of this project lies in the increased awareness of the problems and power of scientific computing in solving real-world problems. The package would be a useful learning aid in all core mathematics courses while providing a valuable tool for applications in other technical courses as well.

## Matrix Representation of Finite Fields

Researcher: Professor William P. Wardlaw

Sponsor: Naval Academy Research Council (ONR) and Naval Research Laboratory

A method of representing the elements of a finite field  $F_q$  as the powers of a matrix  $A$  over its prime field  $F_p$  is presented. The researcher has written two versions of an expository paper on these

results; the first has been published as a Naval Research Laboratory report NRL/MR/5350.1-92-6953, and the second has been submitted to *Mathematics Magazine* for publication.

## Chain Addition Cycles

Researchers: Professor William P. Wardlaw and Associate Professor Jody Lockhart

Sponsors: Naval Academy Research Council (ONR) and Naval Research Laboratory

Let  $m$  and  $s$  be integers greater than 1. An  $(m,s)$  chain addition sequence is an infinite sequence  $a = (a_1, a_2, \dots)$  of elements  $a_k$  of the ring  $Z_m = \{0, 1, \dots, m-1\}$  of integers modulo  $m$  satisfying  $a_{k+s} = a_k + a_{k+1}$  for every positive integer  $k$ , where addition is modulo  $m$ . The researchers define the vectors  $a_k = (a_{k+1}, \dots, a_{k+s})$  in  $(Z_m)^s$ ;  $a_0$  is the seed of  $a$ . Clearly,  $a$  is periodic, with period  $L = L(a) = \min\{k : a_k = a_0\}$ . The researchers call  $a^* = (a_1, \dots, a_1)$  the  $(m,s)$  chain addition cycle generated by the seed  $a_0$  and say

that it has length  $L$ .  $L_s(m)$  denotes the maximum length of all  $(m,s)$  chain addition cycles. The researchers parallel Green and Liebeck (Bracelets, *Math. Gazette* 74) to show (1) if  $a$  is any  $(m,s)$  chain addition sequence, then  $L(a)$  divides  $L_s(m)$  with equality when  $a_0 = (0, \dots, 0, 1)$ ; (2) if  $m$  and  $n$  are coprime, then  $L_s(mn) = \text{lcm}[L_s(m), L_s(n)]$ ; and (3) if  $p$  is prime and  $L_s(p) < L_s(p^2)$ , then  $L_s(p^k) = p^{k-1}L_s(p)$ . Some additional results are obtained regarding values of  $L_s(2)$  and  $L_s(5)$ .

# Independent Research

## Probabilistic Feature Scaling

Researcher: Visiting Professor Ron Benincasa

The researcher reformulated/synthesized the concepts generally accepted in Mahalanobis distance and Bayesian probability in a more logical manner. Mahalanobis distance assumes the "fiction" of variable independence and equal scaling for all feature measures. The Bayesian approach is purely

statistical, again with independence. This effort tries to reformulate/combine these concepts with the probabilistic approach, giving insight into how the Mahalanobis "feature measures" should be scaled.

## A Graph Coloring Interpretation of Proper Partitions of Task Graphs in Parallel Processing Networks

Researcher: Associate Professor Carol G. Crawford

This is a co-operative project with Dr. Stuart Ullman, David Taylor Research Center. In this research the investigators present a new method for utilizing properties of graph colorings for mapping task graphs to parallel processing networks. This research addresses the problem of mapping the modules of a task graph to the processing elements of a parallel computer. The goal of the mapping is

to minimize the total execution complexity of the task, where total execution complexity is the sum of computation and communications complexities within a processor of fixed topology and limited size. This investigation considers the special class of problems where the task precedence graph is an almost full tree, and the parallel processor is connected as a hypercube.

## Reduction Algorithms in Near Chromatic Polynomials

Researcher: Associate Professor Carol G. Crawford

This is an ongoing program of research concerned with almost proper line colorings and Near Chromatic Polynomials, created and first reported by this investigator and Dr. Ruth Bari at the First China-USA International Conference on Graph Theory, Beijing, China. Let  $G$  be a simple  $(p,q)$ -graph with  $q > 0$ . A  $\lambda$  coloring of the lines of  $G$  is almost proper if no three lines incident with the same vertex are assigned the same color. The Near-Chromatic Polynomial of  $G$ , denoted

$N(G;x,y)$ , is a polynomial that, for each integer  $\lambda > 0$ , counts the number of almost proper line colorings of  $G$  in at most colors. Recent results of this project include a generalization of near-chromatic polynomials to include edge colorings with any number of incident edges colored alike. As with earlier results of this work, the investigators have applied their results to problems in experimental design.



## Multistage Sampling

Researcher: Associate Professor Gary O. Fowler

When accounts are audited, there are usually far too many for a complete examination of every account. Auditors therefore sample the accounts and examine only those sampled. They then project the estimate of the errors found in the sample to the entire population of accounts. To improve their precision, multistage sampling is frequently employed. For example, to audit the medicare claims made by hospitals in the United States, an audit may select a random sample of the fifty states, and then stratify hospitals within those states as

large, medium, and small. Finally, a random sample of claims by all large hospitals, and random sample claims from the medium and small hospitals, in proportion to their numbers, could be audited. Estimating the error for the entire population is an easy weighted average. The estimate of the variability is less easy. The approach in this investigation is to view the problem as a special case of a classical nested design in analysis of variance. Good progress has been made, with completion expected early July 1992.

## Approximate Eigenvalues of Non-Self-Adjoint Differential Operators in Thermo-Visco-Elasticity

Researcher: Lieutenant Dennis R. Frazier, USNR

This work is the continuation of work begun for the researcher's master's thesis and more recently done in collaboration with Associate Professors Reza Malek-Madani and Thomas Mahar of the Mathematics Department on the numerical approximation of the spectra of differential operators. The differential operators are approximated by a discrete matrix system of finite difference approximations to the derivatives. The Double Implicit Shifted QR Algorithm ("Double QR") is applied to the matrix to obtain the eigenvalues to the desired accuracy. Double QR is a powerful computational technique for these calculations, because complex eigenvalues can be computed without the need for complex arithmetic.

Therefore, with sophisticated implementation, a personal computer can be used for calculations on large matrices which would otherwise require a mainframe or supercomputer.

The researcher employed this method on self-adjoint operators from quantum mechanics with outstanding success. Recently, this technique has proven successful in approximating the eigenvalues of a non-self-adjoint system of partial differential equations modeling shear in a thermo-visco-elastic bar. The eigenvalues of this system determine the stability of equilibrium solutions. The results have compared very well with analytical results in those special cases where exact eigenvalues can be obtained.

## Logic and Group Actions on Trees

Researcher: Professor Anthony M. Gaglione

In this research, a connection is established between the universal theory of free groups and group actions on  $\Lambda$ -trees where  $\Lambda$  is an ordered Abelian group. It is known that an Abelian group  $G$  acts freely without inversions on a  $\Lambda$ -tree if and only if  $G$  is torsion free. It is also known that an Abelian group  $G$  is torsion free if and only if  $G$  has the same universal theory as a free group of rank  $r$  with  $0 \leq r \leq 1$ . Furthermore, it is also known that the non-Abelian free groups have the same universal theory. The researcher introduces the following terminology due to H. Bass: Let  $\Lambda$  be

an ordered Abelian group. A group  $G$  is called  $\Lambda$ -free if it acts freely without inversions on a  $\Lambda$ -tree  $X$ .  $G$  is called tree-free if it is  $\Lambda$ -free for some ordered Abelian group  $\Lambda$ . The following theorems were proven:

**Theorem 1:** (Gaglione and Spellman). Every non-Abelian group  $G$  having the same universal theory as the non-Abelian free groups is tree-free.

**Theorem 2:** (Gaglione and Spellman). The class of all non-Abelian tree-free group is the model class of some set of universal-existential sentences of first-order group theory.

This research is continuing and since the researcher allows vacuous quantifications, the following is made: CONJECTURE: The class of non-Abelian tree-free groups is precisely the model

class of those universal and existential sentences of first-order group theory true in every non-Abelian free group. The continuing aim will be to either prove or disprove the above conjecture.

## The Logical Existence of a Higher Intelligence

Researcher: Professor Robert A. Herrmann

In this research, basic concepts associated with human intelligence as expressed in physical terminology are modeled by a standard structure. This standard structure is then embedded into an Extended Grundlegen Structure. This yields the deductive-world model. Abstract results generated

by the deductive-world model are then interpreted by modifying the original terminology with the prefix "ultra-." Describing relations between the original physical terminology and this modified terminology appears to yield the logical existence of what can be termed as a higher intelligence.

## Divisibility Properties of Multiple Harmonic Sums

Researchers: Associate Professors Michael E. Hoffman and Courtney H. Moen

Let  $\zeta_{n(m)}$  denote the harmonic sum  $\sum_{i=1}^n \frac{1}{i^m}$

There are various well-known results about

divisibility of these sums by a prime  $p$  when  $n = p-1$ . For example, if  $p > m+1$ , then  $p$  divides the numerator of  $\zeta_{p-1}(m)$ . The researchers seek to generalize such results to the multiple harmonic sums

$$A_n(i_1, i_2, \dots, i_k) = \sum_{n \geq a_1 > a_2 > \dots > a_k \geq 1} \frac{1}{a_1^{i_1} a_2^{i_2} \dots a_k^{i_k}}$$

Results: If  $n = p-1$ , several divisibility results can be obtained immediately from the single-sum case and some earlier results of the first author. But a new phenomenon occurs in the multiple sum case:

there are interesting divisibility results when  $k$  is even and  $n = 2p-1$ . The authors have shown that for  $k \leq 4$  and prime  $p$ , the sum

$$S_{k,i} = \sum_{i_1 + \dots + i_k = i} A_{2p-1}(i_1, \dots, i_k)$$

is divisible by  $p$  if  $p > i+1$ . The researchers conjecture this is true in general, and they hope to

prove the conjecture stated above. They will submit a paper based on their results as soon as possible.

## Restricted Orbit Equivalence for Actions of $\mathbb{Z}^d$

Researcher: Assistant Professor Janet W. Kammeyer

The central question in Ergodic Theory is to ask whether two dynamical systems are "the same." For example, suppose  $(X, \mathcal{A}, \mu)$  is a Lebesgue probability space. Let  $T$  be a measure preserving, finite entropy ergodic  $\mathbb{Z}$ -action on  $(X, \mathcal{A}, \mu)$ . Two such systems are said to be orbit equivalent if there exists a bimeasurable, measure preserving map  $\phi$  between them which preserves the  $T$ -orbits, as sets. In 1959, H. Dye proved that any two ergodic  $\mathbb{Z}$ -actions are "the same," in the sense that they are orbit equivalent.

If more restrictions are placed on this orbit equivalence  $\phi$ , so that, for instance, the map  $\phi$  must also preserve the order of the orbits, then any two ergodic  $\mathbb{Z}$ -actions which are orbit equivalent in this restricted sense are said to be isomorphic. In 1970, D. Dornstein proved that any two Bernoulli (i.e., independent)  $\mathbb{Z}$ -actions of equal entropy are "the same," in the sense that they are isomorphic.

These two notions of "sameness" may be thought of as two ends of a spectrum of restricted orbit equivalence, with orbit equivalence putting essentially no restriction on  $\phi$  and isomorphism

putting a quite rigid restriction on  $\phi$ . In 1985, D. Rudolph published a general theory of restricted orbit equivalence for  $\mathbb{Z}$ -actions. He defined the "size,"  $m$ , of an orbit equivalence, and defined what it meant for two  $\mathbb{Z}$ -actions to be "the same" in the sense of being  $m$ -equivalent. He then proved a theorem which gave a characterization of those  $\mathbb{Z}$ -actions which are  $m$ -equivalent.

This researcher, working jointly with D. Rudolph (University of Maryland), is developing a notion of restricted orbit equivalent for ergodic actions of the higher dimensional group  $\mathbb{Z}^d$ . The concept of a "size" is first developed from an axiomatized notion of the size of a permutation of a finite block in  $\mathbb{Z}^d$ . This is extended to orbit equivalences which are cohomologous to the identity and, via the natural completion, to a notion of restricted orbit equivalence. This is shown to be an equivalence relation. This work is in the process of being written and submitted for publication. The authors are also continuing the work by proving a theorem which characterizes those ergodic  $\mathbb{Z}^d$ -processes which are equivalent in this restricted sense.

## A Transient Analysis of a High Conversion Core APWR Design

Researcher: Lieutenant Charles P. Kliever, USN

Parametric investigations conducted earlier examined the suitability of using improved hexagonal and square fuel lattice arrangements to convert operational Pressurized Water Reactors into a transitional Advanced Pressurized Water Reactor hybrid. Imposing the constraint that any core modification must be capable of being retrofitted into existing PWR cores, the author developed a 20x20 Idealized Fuel Lattice Design (IFD) that permitted a 38% increase in the number of fuel rods compared to a standardized 17x17 fuel assembly design by Westinghouse. This IFD can be adapted into functional 19x19, 20x20, or 21x21 fuel design formats. The 20x20 IFD was comparatively

analyzed with the 17x17 operational fuel design utilizing a modified version of the COBRA-IV thermohydraulic code. Steady state analysis yielded unacceptable core pressure differentials that precluded the further consideration of the hexagonal formats. The transient analysis proceeded with the 20x20 IFD and 17x17 cores. Using transient scenarios that simulated a range of abnormal event severities, it was found that the 20x20 IFD core design out-performed the reference core and actually improved upon previously established safety design criteria utilized for core design acceptance. This paper summarizes those results and describes the simulations used for the analysis.

## Integro-Operator Equations in Hilbert Space

Researcher: Associate Professor Thomas J. Mahar

The stability analysis of thermo-visco-plastic models of shear band formation leads to a complicated integro-partial differential equation. Transform methods were used by this researcher to solve the problem without assuming a spectral decomposition theorem for the original, non-self-adjoint system. The present work extends this analysis to a much

broader class of problems. It is proved that the original, non-self-adjoint system does not have a complete set of product solutions. This, in turn, proves that the eigenfunctions of the original, non-self-adjoint problem are not complete. The most general version of this analysis leads to a renewal equation in an infinite-dimensional Hilbert space.

## Fractals and Chaos

Researcher: Professor Mark D. Meyerson

Fractal dimension and Lyapunov exponents can help quantify random appearing events such as radar backscatter. Such analysis can be used for clutter

rejection schemes and for construction of a model for radar sea scatter.

## Whittaker Functions for Covering Groups of $GL(u)$

Researcher: Associate Professor Courtney Moen

It is well known that the Whittaker function  $K_m(s,y)$  appearing in the Fourier expansion of the classical Eisenstein series formed with a multiplier simplifies at the value  $s = \frac{1}{2}$  where the Eisenstein series has a pole. The value  $K_m(\frac{1}{2},y)$  is the Whittaker function associated with the classical theta function.

This phenomenon is reflected in the behavior of the Whittaker functions attached to a certain principal series representation of the 2-sheeted cover of  $GL(2)$  over a local field. This project investigates the analogue of this situation in the general case of covering groups of  $GL(n)$ .

## Functions in Generalized Pinchuk Classes

Researcher: Associate Professor E. John Moulis

Let  $N$  be the set of all functions  $f$  analytic in  $|z| < 1$ , having the form  $f(z) = z + \sum_{n=2}^{\infty} a_n z^n$ .

The researcher continues studying the class  $U_k(\beta, c, \lambda)$  of generalized Pinchuk functions  $f$  in  $N$  which are defined by

$$\int_0^{2\pi} |Re [e^{ik} J_f - \beta \cos \lambda]| d\theta \leq k\pi(1-\beta) \cos \lambda ,$$

with  $J_f = 1 - \frac{1}{c} + \frac{z}{c} \frac{f}{f}$ ,  $z = re^{ic}$ ,  $0 \leq r < 1$ ,  $c$  a

non-zero complex number,

$$-\frac{\pi}{2} < \lambda < \frac{\pi}{2}, \quad 0 \leq \beta < 1, \quad k \geq 2 .$$

When  $z^k$  is in  $U_k(\beta, c, \lambda)$ ,  $f$  is said to belong to a generalized Moulis class  $V_k(\beta, c, \lambda)$ , named after

this researcher who introduced the basic class  $V_k(0,0,\lambda)$  in his Ph.D. thesis .

The researcher continues to try to find sharp bounds, in terms of the parameters  $k$ ,  $\beta$ ,  $\lambda$ , and  $c$ , the usual geometric mapping properties of functions in these classes, including distortion and rotation bounds as well as bounds on the series coefficients  $a_n$  .

## Future Carrier Study

Researcher: Lieutenant Commander Richard K. Phares, USN

The researcher served as a member of the Roles, Missions and Threats Panel of the Future Carrier Study, under Dr. Peter Perla of the Center for Naval Analyses. The project which began last year was completed. The final brief was presented to

OP-05 in November 1991 recommending continued use of large mono-hull carriers while placing Research and Development dollars into STUVL aircraft. The researcher generated a number of slides used in the final briefing and the final paper.

## Joint Force Air Component Commander Study

Researcher: Lieutenant Commander Richard K. Phares, USN

The Center for Naval Analysis is tasked by OP-607 to provide insight into the Navy's role in Joint Air Operations, particularly with relation to the JFACC (Joint Force Air Component Commander.) The

researcher is co-authoring a working paper with Mr. Barry Messina of the Center for Naval Analysis, concerning the historical use of air power in joint operations.

## Representation of Non-Linear Stress-Strain Relations for Transversely-Isotropic Materials

Researcher: Associate Professor John F. Pierce

The Cartan decomposition of the space of symmetric three-matrices by the adjoint action of the two-dimensional orthogonal group is used to generate a basis for the module of all polynomial mappings of the symmetric three-matrices into

itself. The module is then identified as the collection of all non-linear stress-strain response functions of the second Piola-Kirchhoff type which are transversely isotropic.

## Symmetry-Breaking Loads and Orbits of Static Equilibria for Pseudo-Rigid Bodies

Researcher: Associate Professor John F. Pierce

Algebraic Geometry and Singularity Theory are used to determine how the orbits of static equilibrating configurations for a pseudo-rigid body are altered when loads are applied which break the

symmetry of the material response. The analysis produces a first classification of the bifurcation patterns for the load.

## On House-Swapping with Money

Researcher: Visiting Assistant Professor Thomas Quint

In this paper the researcher considers "one-sided" models for an economically indivisible good, i.e., those where each trader can act as both "buyer" and "seller" of the good. The idea of the paper is to apply techniques from the (better developed) theory of "two-sided" markets to analyze these one-sided models.

First the researcher considered Shapley and Scarf's model without money. Gale's top trading cycle (TTC) algorithm finds a core outcome for these games. It is argued that, if one thinks of each trader as both buyer and seller of a house, the TTC algorithm resembles the deferred accounting procedure used to find a core point in Gale-Shapley's two-sided model.

Next is considered a house swapping game with

transferable utility (TU). Curiel and Tys have already shown core points can be found by adding together optimal dual variables of the assignment linear program. Hence, each player's core payoff is just the sum of his assignment game core payoff as "buyer" and as "seller." The researcher shows all core points can be found this way. So again, they show an analogous result to what is known for two-sided models.

Finally, the researcher considers a more general class of non-transferable utility games which are best described as one-sided analogues of Demangs-Gale's two-sided games. The researcher provides an analogue of Crawford-Knoer's algorithm for finding a core point of these games under certain conditions.

## Subsidization vs. Taxation in Cooperative Game Theory

Researcher: Visiting Assistant Professor Thomas Quint

The researcher considers the transferable utility (TU) games which have empty cores. These can be "balanced" either by increasing the worth of the grand coalition (subsidization) or by decreasing the worth of smaller coalitions by taxing communication

between players. The researcher shows that the necessary amount of such "taxation" is always at least as much as the amount of necessary subsidization. This is a cooperative research effort with Juan Cesco.

## The Geometry of Hopf Maps

Researcher: Associate Professor JoAnn S. Turisco

This work is an investigation of the geometry of normed bilinear maps and the quadratic mappings between spheres which arise from their Hopf construction. The ultimate aim of this study is the determination of the dimensions in which such mappings exist.

It has been shown (P.Y.H. Yiu and K.Y. Lam) that the image of the restriction of a normed bilinear map  $B$  to spheres  $B_0 : S^{p-1} \times S^{q-1} \rightarrow S^{r-1}$  is a real algebraic variety  $V$  in  $S^{r-1}$ . Results have been obtained by considering the cohomology of  $V$ . In particular, the existence of a normed bilinear

map  $B : R^{16} \times R^{28}$  would lead to a contradiction in the imbedding theory of simplicial complexes.

A result due to P.Y.H. Yiu is that any quadratic map between spheres can be partitioned into sphere bundles, i.e., restrictions of the map to certain subspaces give great sphere bundle projections. It can be determined when a quadratic map is the Hopf construction of a normed bilinear map. This work uses the above results and techniques together with the computation of the following integrals to examine further the geometry of quadratic mappings of spheres. These results are due to Professor T. Ono.

Let  $f_v(\zeta) = \int_{S^{n-1}} \langle \zeta, f(x) \rangle^v d\omega_{n-1}$  for  $v$  a

$$\sigma_{2k}(f_v) = \begin{cases} \left( \frac{1}{2}, k \right) \\ \frac{1}{k!} {}_2F_1 \left[ -k, \frac{1}{2}; 1 - \varrho^2 \right], n-1 \\ \frac{1}{2k+1} {}_2F_1 \left[ -k, 1; \frac{3}{2}; 1 - \varrho^2 \right], n-2 \end{cases}$$

This researcher computed some integrals corresponding to general Hopf maps. For example,

nonnegative integer,  $f : R^n \rightarrow R^m$  a smooth map,  $d\kappa_{n-1}$  the volume element giving  $S^{n-1}$  volume 1, and  $\langle, \rangle$  the standard inner product. (If  $f$  is an affine map, the function  $f_v$  is the Legendre polynomial of order  $v$ .) The mean value  $\sigma_v(f)$  of  $f_v$  on  $S^{m-1}$  is  $\sigma_v(f) = \int_{S^{m-1}} f_v(\zeta) d\kappa_{m-1}$ . This number depends on the norm:  $N_k(f) = \int_{S^{n-1}} |f(x)|^{2k} d\kappa_{n-1}$ ,  $v = 2k$ . Since  $N_k(f) = 1$  whenever  $f : S^{n-1} \rightarrow S^{m-1}$ , these numbers measure a deviation of  $f$  from being spherical. T. Ono showed that  $\sigma_{2k}(f_p)$  is a hypergeometric polynomial if  $f_p$  is a certain deformation of the classical Hopf fibration  $f : S^{2n-1} \rightarrow S^n$ :

if  $f : S^{n-1} \rightarrow S^{n-1}$ , then :

$$(f_p)_v(\zeta) = \left( \frac{n-2}{n-2+2v} \right) \zeta^v {}_3F_2 \left[ \frac{1}{2}, -\frac{v}{2}, -\frac{v}{2} + \frac{1}{2}; -\frac{v}{2} + \frac{4-n}{4}, -\frac{v}{2} + \frac{6-n}{4}; z \right]$$

where

$$z = \frac{\zeta_1^2 + \varrho^2(\zeta_2^2 + \dots + \zeta_n^2)}{\zeta_1^2}$$

The forms  $f_v$  are computed (T. Ono) using the generating function  $\sigma(f; t) = \sum_{v=0}^{\infty} \sigma_v(f) \frac{t^v}{v!}$ , a mean value theorem in potential theory, and the eigenvalues of the symmetric matrix  $A_p(\zeta)$ , where

$\langle \zeta, f(x) \rangle = {}^t x A_p \tilde{x}$ , for  $f$  a quadratic map. Since the computations are lengthy, this researcher intends to use the computer to generate more examples.

## Minimum and Characteristic Polynomials of Low-Rank Matrices

Researcher: Professor William P. Wardlaw

Let  $R$  be a commutative ring with identity and let  $A$  be an  $n \times n$  matrix over  $R$  with spanning rank  $sr(A) = r$ . A simple polynomial identity is used to show that  $A$  satisfies a modified Cayley-Hamilton equation  $A f_D(A) = 0$  of degree  $r+1$ , where  $f_D(x)$  is the characteristic polynomial of a suitably

chosen  $r \times r$  matrix  $D$ . Moreover, the characteristic polynomial of  $A$  is  $f_A(x) = x^{n-r} f_D(x)$ . An algorithm is given for calculating  $D$ , and methods are suggested for finding the minimum polynomial of  $A$  when it exists.

# Research Course Projects

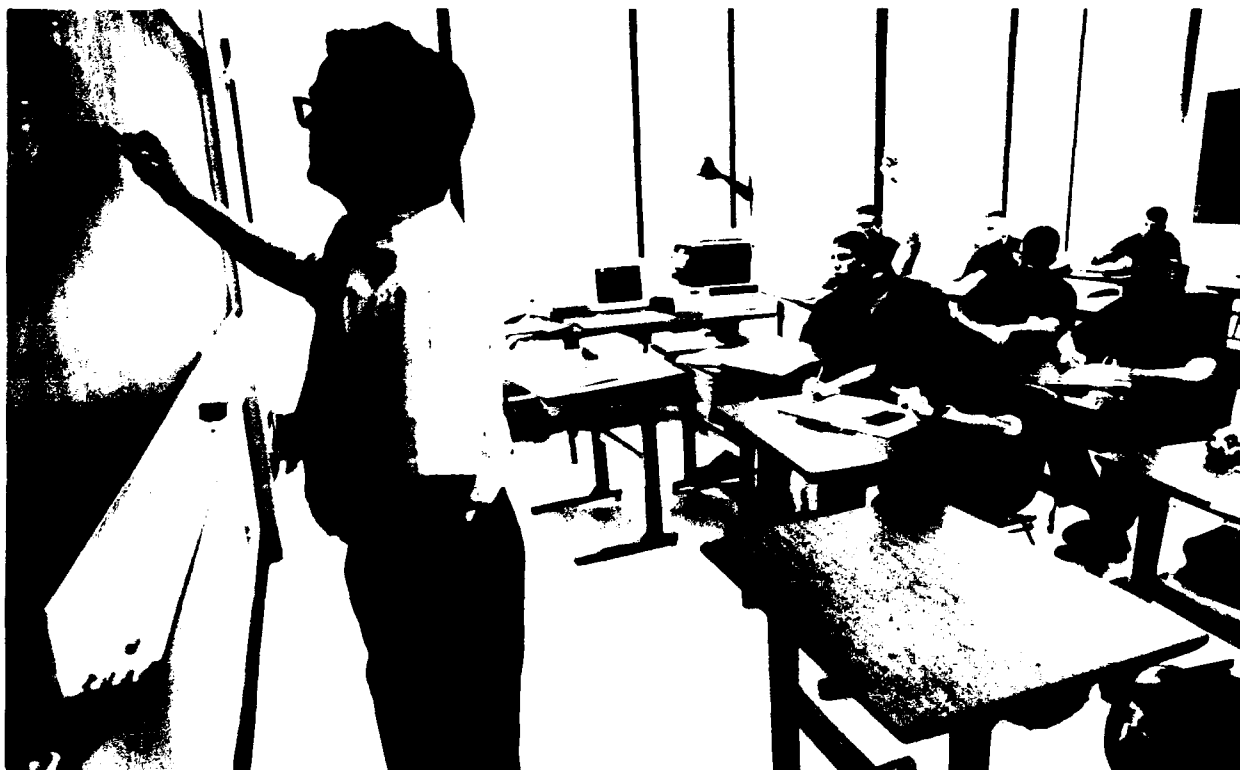
## Public Works Manpower Study

Researchers: Ensign Daniel L. Forry, USN, and Midshipman 1/C Vincent C. Vertin, USN  
Advisers: Professor W. Charles Mylander and Lieutenant Bret Muilenburg, USN

Public Works is very slow in responding to service requests to deal with non-emergency repairs both in Bancroft Hall (Work Center 17) and the rest of the Academy, including the housing areas (Work Center 19). This study sought to determine what the staffing levels must be in the various skill areas (e.g., carpentry, glazing, plumbing, etc.) to provide satisfactory responses to service requests and to determine the role of waiting for specially ordered materials as a cause of poor response. Working with Lieutenant Muilenburg and Ensign Woomer, data was collected and compiled for the service requests for the two work centers for the period from July 1991 to December 1991. A casual examination of the data clearly indicated that delays caused by waiting for specially ordered materials was not a problem.

The data for Work Center 17 was used to

estimate the parameters for a non-preemptive priority-discipline Mark off input/Mark off output/S servers queuing model. The model was evaluated using current manning levels in Work Center 17 and predicted long times to complete service requests in line with the times being observed. The model also indicated in some skill areas service requests require significant levels of overtime to keep the backlog from growing forever. This, too, is consistent with the observations of Work Center 17. The queuing model was the one used in a systematic search for a better balance of manning levels among skill categories and the number of additional employees needed. It was determined that: one glazer, one painter, and two plumbers are needed to complete Work Center 17 typical flow of service requests without overtime.





## Publications

ANDRE, Pierre P., Professor, "A Detection Model for Non-Acoustic Detection of an SSBN," Applied Physics Laboratory, Johns Hopkins University Report, August 1991.

This report describes an analytic model which gives the probability that a patrolling SSBN will be detected by non-acoustic means by a randomly patrolling enemy attack boat.

BAKER, B. Mitchell, Associate Professor, co-author, "Positive Polynomials and Time Dependent Integer-Valued Random Variables," *Canadian Journal of Mathematics*, 44, 1 (1992), 3-41.

This paper investigates the asymptotic behavior of time-dependent random walks on the integer lattice in one dimension. In particular, classical questions of positivity concerning multiplication of polynomials arise when studying the  $K_0$ -groups for a certain class of operator algebras. To obtain a complete isomorphism invariant for these algebras, one needs to determine its order structure, i.e., the positive cone. This may be reduced to analyzing local flatness conditions on sums of random variables which depend on (discrete) time. For a large class of one-dimensional random walks, necessary and sufficient conditions were obtained for these asymptotic flatness properties, which resulted in detailed knowledge of the isomorphism classes and trace structures on the associated operator algebras.

BUCHANAN, James L., Professor, and Peter R. TURNER, Associate Professor, *Numerical Methods and Analysis*. New York: McGraw Hill, 1992.

*Numerical Methods and Analysis* is a senior level undergraduate or first graduate text in Numerical Analysis with its emphasis clearly rooted in practical applications. The desire to develop good numerical routines for solving problems drives the mathematical development rather than the other way around, but the methods presented are analyzed fully. Coverage includes computer arithmetic and errors, iterative solution of nonlinear equations, evaluation of elementary functions, interpolation, approximation and curve-fitting (including splines, Bezier curves and Fast Fourier Transform), linear systems of equations, optimization, numerical integration, numerical solution of differential equations, boundary value problems, eigenvalues, and an introduction to the

ideas of parallel processing.

CRAWFORD, Carol G., Associate Professor, co-author, "Automated Fingerprint Identification for the Federal Bureau of Investigation," Federal Bureau of Investigation Technical Report, October 1991.

This technical report presents results of a cooperative research project to discover and apply innovative methods of artificial intelligence to automated fingerprint identification for the Federal Bureau of Investigation. The researchers developed methods utilizing relaxation algorithms including snakes, splines, elastic nets, and smoothed local symmetries. Special emphasis was given to deriving methods combining graph matching and neural networks.

D'ARCHANGELO, James M., Professor, co-author, "Acoustic Resonance Spectroscopy for Elastic Spheroids of Varying Aspect Ratios, and the Level Crossing Phenomenon," *Journal of the Acoustical Society of America*, 88, 6 (December 1990), 2822-2829.

The "level crossing" phenomenon, which has been pointed out earlier [M. F. Werby, et al., *Journal of Acoustical Society of America*, 84 (1988), 1425-1436], is studied here for solid elastic spheroids of varying aspect ratios. Using a T-matrix code, the frequencies (both fundamentals and overtones) of the resonances are calculated as excited by an end-on incident plane wave. Aspect ratios of the tungsten carbide spheroids range from  $b/a = 1$  (sphere) to 4 in steps of 0.25. The resonance frequencies are presented in the form of an acoustic spectroscopic level scheme. They are expressed in units  $kb$  ( $b$  = semimajor axis) and correspond to resonating surface waves as they form standing waves around the meridional circumference. While for the resonating Rayleigh waves the resonance frequencies only rise gradually with increasing aspect ratio, those for the Whispering Gallery waves rise much more rapidly, and hence successively cross over the various overtones of the Rayleigh resonances. This phenomenon is explained on the basis of the different character of the dispersion curves (phase velocity versus frequency) for the Rayleigh and the Whispering Gallery waves, as calculated in an exact fashion for a tungsten carbide (WC) sphere and used locally on the spheroids.

DUFFY, Dean G., Visiting Associate Professor, "The Response of Floating Ice to a Moving, Vibrating Load," *Cold Regions Science and Technology*, 20 (December 1991), 51-64.

The researcher investigated the wave motion in floating sea ice that results from a moving, vibrating load. For a fixed driving frequency, increasing the speed of the load results in shorter, smaller amplitude waves ahead and longer, larger amplitude waves behind the load. For realistic loads, the mass of the load may be neglected. If the mass of the load is small, then resonant solutions are found.

GAGLIONE, Anthony M., Professor, "A Theorem on Free Products of Special Abelian Groups," *Groups St. Andrews* 1989, 1 (1991), 148-154.

In a previous paper, the quotient groups of the lower central series  $G_n/G_{n+1}$  were studied where  $G$  was assumed to be a free product of a finite number of finitely generated Abelian groups and  $G_n$  denotes the  $n$ th term of the lower central series. In this paper an improved proof of a very complex result which previously appeared is given. This represents a significant simplification of previous results.

GAGLIONE, Anthony M., Professor, "Some Model Theory of Free Groups and Free Algebras," Naval Research Laboratory Report, NRL/MR/4440-92-6967, 30 April 1992.

This paper treats some aspects of the model theory of groups and algebras free in a variety. Specifically, the persistence of universal and existential formulas is studied; moreover, some observations about positive and negative sentences are made as well. The paper falls naturally into three parts. In the first part, the concepts of  $(B+3N)$ -discrimination and strong discrimination are elucidated upon. In the second part, the researcher gives himself a non-Abelian free group  $F$  and considers its relation to the Baumslag construct  $K = (F * F; u = u)$  where  $F = F$  and  $u$  is not a proper power in  $F$  (neither is  $u$  a proper power in  $F$ ). The researcher investigates the model class of the theory of the non-Abelian free groups in this part. In the third and last part, the researcher considers the equation  $[y_1, y_2] = x_1^2 x_2^2$  (here  $[y_1, y_2] = y_1^{-1} y_2^{-1} y_1 y_2$ ) in a free group and ponders its implications for questions arising from the second part. The researcher concludes with a list of questions which to the best of his knowledge remain open.

GOTAY, Mark J., Associate Professor, "A Multisymplectic Approach to Classical Field Theory II: Space + Time Decomposition," *Differential Geometry Applications* 1 (1991), 375-390.

In a previous paper the researcher laid the foundations of a covariant Hamiltonian framework for the calculus of variations in general. The purpose of the present work is to demonstrate, in the context of classical field theory, how this covariant Hamiltonian formalism may be space + time decomposed. It turns out that the resulting "instantaneous" Hamiltonian formalism is an infinite-dimensional version of Ostrogradskii's theory and leads to the standard symplectic formulation of the initial value problem. The salient features of the analysis are: (1) the instantaneous Hamiltonian formalism does not depend upon the choice of Lepagean equivalent; (2) the space + time decomposition can be performed either before or after the covariant Legendre transformation has been carried out, with equivalent results; (3) the instantaneous Hamiltonian can be recovered in a natural way from the multisymplectic structure inherent in the theory; and (4) the space + time split symplectic structure lives on the space of Cauchy data for the evolution equations, as opposed to the space of solutions thereof.

GOTAY, Mark J., Associate Professor, "An Exterior Differential Systems Approach to the Cartan Form," *Symplectic Geometry and Mathematical Physics*, eds. P. Donato et al., Birkhauser, 1991, pp. 160-188.

The researcher shows that given a Hamiltonian action of a compact and connected Lie group  $G$  on a symplectic manifold  $(M, \omega)$  of finite type, there exists a linear symplectic action of  $G$  on some  $R^{2n}$  equipped with its standard symplectic structure such that  $(M, \omega, G)$  can be realized as a reduction of this  $R^{2n}$  with the induced action of  $G$ .

GOTAY, Mark J., Associate Professor, co-editor, "Mathematical Aspects of Classical Field Theory," *Proceedings of the AMS/IMS/SIAM Joint Summer Research Conference*, Seattle, Washington, July 1991, Contemporary Math (1992).

The author presents a new method of constructing a stress-energy-momentum tensor for a classical field theory based on covariance considerations and Noether theory. The stress-energy-momentum tensor  $T^{\mu\nu}$  that the author constructs is defined using the (multi)momentum map associated to the spacetime diffeomorphism group. The tensor  $T^{\mu\nu}$  is uniquely determined as well as gauge-covariant, and depends only upon the divergence equivalence class of the Lagrangian. It satisfies a generalized version of the classical Belinfante-Rosenfeld formula, and hence naturally incorporates both the canonical stress-energy-momentum tensor and the "correction terms" that are necessary to make the latter well behaved. Furthermore, in the presence of a metric on spacetime, our  $T^{\mu\nu}$  coincides with

the Hilbert tensor and hence is automatically symmetric.

GOTAY, Mark J., Associate Professor, co-author, "A Symplectic Analogue of the Mostow-Palais Theorem," *Symplectic Geometry, Groupoids, and Integrable Systems*, eds., P. Dazord and A. Weinstein, M.S.R.I. Publ. 20, Springer-Verlag, 1991, pp. 173-182.

The notion of a "Lepagean equivalent" of a given variational problem is defined, and the basic properties of these objects are sketched. Using some ideas of Bryant, Dedecker, and Griffiths, the researcher shows that every constant rank variational problem has a canonical Lepagean equivalent and that, as a consequence, to every such variational problem there is assigned a canonical "generalized Cartan form." These observations rely crucially upon the exterior differential systems approach to the calculus of variations. Then the author proves that this generalized Cartan form is universal in the sense that every Cartan form for a classical variational problem can be obtained from it by pullback upon sectioning a certain bundle. These results lead to a simple new proof of the existence of Cartan forms for classical variational problems, and explain in intrinsic terms why and to what extent classical Cartan forms are (typically) not uniquely determined by a Lagrangian.

HOFFMAN, Michael E., Associate Professor, "Multiple Harmonic Series," *Pacific Journal of Mathematics*, 152, 2 (1992), 275.

The researcher considers several identities involving the multiple harmonic series

$$\sum_{n_1 > n_2 > \dots > n_k \geq 1} \frac{1}{n_1^{i_1} n_2^{i_2} \dots n_k^{i_k}}$$

which converge when the exponents  $i_j$  are at least 1 and  $i_1 > 1$ . There is a simple relation of these series with products of Riemann zeta functions (the case  $k = 1$ ) when all the  $i_j$  exceed 1. There are also two plausible identities concerning these series for integer exponents, which the researcher calls the sum and duality conjectures. Both generalize identities first proved by Euler. The researcher gives a partial proof of the duality conjecture, which coincides with the sum conjecture in one family of cases. The researcher also proves all cases of the sum and duality conjectures when the sum of the exponents is at most 6.

KIDWELL, Mark E., and Mark D. MEYERSON, Professors, "Halving It All," *Quantum*, 2, 4(March/April 1992), 7 - 11.

The family of all area bisectors of a polygon form hyperbolic envelopes--so do families of lines cutting off any fixed area from the polygon. For conic sections, families of lines cutting off fixed area form curves of the same type. There are nonsymmetric regions whose area bisectors are all concurrent.

KONKOWSKI, Deborah A., Associate Professor, "Singularities in Colliding Plane-Wave Spacetimes," *Proceedings of Gravitation: A Banff Summer Institute*, (1991), pp. 113-120.

Singularities in colliding plane-wave spacetimes are studied. Colliding impulsive gravitational plane-wave spacetimes and colliding sandwich gravitational plane-wave spacetimes are shown to possess quasiregular singularities while colliding thick gravitational plane-wave spacetimes have nonscalar curvature singularities. It is argued that these singularities are generally unstable. Scalar and electromagnetic wave perturbations support this result. However, a special subset of electromagnetic modes does not lead us to predict a scalar curvature singularity. A quasiregular singularity is predicted instead, and it is confirmed in the colliding gravitational-and electromagnetic-wave spacetime of Chandrasekhar and Xanthopoulos.

LOCKHART, Jody M., Associate Professor, "The Conjugacy Problem for Graph Products with Infinite Cyclic Edge Groups," *Proceedings of the American Mathematical Society*, 114 (1992), pp. 603-606.

Finite graph products of groups with solvable conjugacy problem and with infinite cyclic edge groups are considered. It is shown that the graph product has solvable conjugacy problem if the images of the edge group generators in each vertex group  $G_v$  are powers of a common central element  $c$  where the group generated by  $c$  has solvable generalized word problem in  $G_v$ .

The proof is in two parts. First, for each pair of vertices  $(v,w)$ , a set  $C(v,w)$  of ordered pairs of integers is defined, and it is shown that the graph product has solvable conjugacy problem if  $C(v,w)$  is recursive for each pair of vertices  $(v,w)$ . Then, a finitely presented commutative semigroup  $S$  is constructed such that membership in  $C(v,w)$  is reducible to the word problem in  $S$ . Since every finitely presented commutative semigroup has solvable word problem, it follows that the graph product has solvable conjugacy problem.

MALEK-MADANI, Reza, Associate Professor, "Steady-state Shear Bands in Thermo-Plasticity: Part I - Vanishing Yield Stress," *International Journal of Solids and Structures*, 29, 16 (1992), 2039-2061.

This paper concerns the construction and stability properties of steady-state solutions of a system of partial differential equations that model simple shearing of a slab of thermo-plastic material. The class of constitutive laws that give rise to a variational formulation of the steady-state problem is identified, and a phase-plane argument is used to construct time-independent solutions that may be interpreted as steady-state shear bands. The variational framework captures several commonly adopted constitutive laws. Techniques from bifurcation theory for variational problems are applied to classify stable and unstable solutions merely in terms of the shape of the solution branch in the distinguished bifurcation diagram that arises when average strain-rate is plotted against shearing force on the boundary. First, the two problems in which loading is imposed by either stress boundary conditions or velocity boundary conditions are treated by one analysis, and the differing stability properties of solutions are explained naturally. Second, the stability analysis is based upon a symmetric eigenvalue problem arising from the appropriate second variation. The link with dynamic behavior is made through a Lyapunov functional, and the linearized dynamics are not considered directly. Provided the proper existence theorems for the time-dependent problem can be proven or are assumed, the Lyapunov approach yields the appropriate nonlinear dynamic stability properties of steady-state solutions. In this paper the researcher shall consider the case in which vanishing strain-rate implies zero stress, i.e., there is no residual or yield stress present in the model, but analysis can be extended to encompass constitutive laws modelling nonzero yield stress.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "Programs for a Logic Course," *The College Mathematics Journal*, 22, 3 (June 1991), 235-241.

This article is a discussion of the attributes of PROLOG and its use in a logic course. Programs written and executed by students which greatly enhance their understanding of the course are given as examples.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "ADA in a Theoretical Mathematics Course," *The Mathematics and Computer Education Journal*, 25, 2 (Spring 1991), 131-143.

This paper is a discussion of the various properties

of ADA which make it useful in investigating the theoretical properties of mathematical systems. Sample ADA programs are given.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "Lanchester's Square Law, An Application of a System of Differential Equations," *The Mathematics and Computer Education Journal*, 26, 1, (Winter 1991), 61-65.

This paper provides an example of an application of Differential Equations to military planning. The result is Lanchester's famous square law.

MCCOY, Peter A., Professor, "Solutions of the Helmholtz Equation Having Rapid Growth," *Complex Variables*, Erwin O. Kreyszig 70th Birthday Volume, 18, 1-2 (1992), 91-101.

Function Theoretic Methods characterize the growth of solutions of the Helmholtz equation on  $R^2$ . Solutions of infinite order and type are identified through coefficient and Bernstein type approximation theorems.

MICHAEL, T. S., Assistant Professor, "The Decomposition of the Complete Graph into Three, Isomorphic, Strongly Regular Graphs," *Congressus Numerantium*, 85 (1991), 177-183.

In a problem in the *American Mathematical Monthly*, Professor Schwenk (formerly of the Naval Academy) asked whether the complete graph on ten vertices admits a decomposition into three copies of the Petersen graph. He deployed a clever linear algebraic argument to show that such a decomposition is impossible. In this paper the researcher shows that the complete graph on  $n$  vertices can be decomposed into three copies of a strongly regular graph only under certain highly restrictive conditions on the parameters. Schwenk's result is a special case of our main theorem.

PENN, Howard L., Professor, and Craig K. BAILEY, Associate Professor, "The USNA Calculus Initiative," *The Laboratory Approach to Teaching Calculus*, *Mathematical Association of America Notes*, 20, (1991), 127-133.

In this paper the researchers present several examples of the types of assignments that are made in Calculus I, II and III. These problems emphasize the concepts and applications of Calculus. They make the connection between the analytic and geometric representation of equations. Numerical Approximation is also stressed. A total of eight assignments are covered.

PENN, Howard L., Professor, and Craig K. BAILEY, Associate Professor, Instructor's Resource Guide to Swokowski's Calculus Fifth Edition Using Mathematics Plotting Package (MPP). Boston: PWS-Kent Publishing Company, 1991.

These 200 pages supplement present examples and exercises tied to Swokowski's *Calculus*, Fifth Edition, using MPP, the Calculus Program written at the Naval Academy. The book includes computer disks containing a large number of example files that are tied directly to examples in the supplement. Most of these examples are directly related to materials present in the Calculus textbook. Many other applications are covered that cannot be presented well without the use of a computer program.

PRICE, Geoffrey L., Associate Professor, co-author, "Index Theory and Second Quantization of Boundary Value Problems," *Journal of Functional Analysis*, 104 (1992), 243-290.

Working independently, William Arveson and Robert Powers have recently obtained a numerical index for one-parameter semigroups of endomorphisms of the algebra of bounded operators on a Hilbert space,  $B(5)$ . This index is invariant under bounded perturbations of the infinitesimal generator of the semigroup. In the paper cited above, the authors have used the Arveson-Powers index as a motivation to obtain an index for quasi-free derivations on  $B(5)$ . In the overlapping cases the two index theories coincide. The construction of this index makes use of an indefinite inner product space associated with the anti-symmetric Fock space, and requires a result about cores for unbounded symmetric linear operators which the authors expect will be of independent interest.

QUINT, Thomas, Assistant Professor, "The Core of an M-Sided Assignment Game," *Games and Economic Behavior*, 3 (1992), 487-503.

A generalization of Shapley-Shubiks (1992) housing market is considered in which there are  $m$  types of agents instead of two. These games can have non-empty cores. A subclass of such games with non-empty cores is presented.

QUINT, Thomas, Assistant Professor, "Necessary and Sufficient Conditions for Balancedness in Partitioning Games," *Mathematical Social Sciences*, 22 (1992), 87-91.

This paper considers the class of partitioning games which include the bridge game, the assignment

game, the consecutive game, and the  $m$ -sided assignment game. The author provides necessary and sufficient conditions for core existence in these games.

QUINT, Thomas, Assistant Professor, "Characterization of Cores of Assignment Games," *International Journal of Game Theory*, 19 (1992), 413-420.

The author considers the assignment game of Shapley and Shubik. It is proved that the class of possible cores of such games (expressed in terms of payoffs for players on one side of the market) is exactly the same as a special class of polytopes called "45<sup>o</sup>-lattices."

STUCKER, Aaron I., Assistant Professor, "Group Problem Solving," *PRIMUS*, II (March 1992), 39-44.

Examples of group problems that excite students are given. Methods for employing these problems are presented.

SANDERS, Thomas J., Professor, "DTED Map Program Software," The Johns Hopkins University Applied Physics Laboratory Technical Report.

This software was written in the C language to display and manipulate Digital Terrain Elevation Data (DTED) files on a Macintosh computer. As part of the *Strike Warfare Effectiveness and Survivability Analysis System*, this program can aid in the design and implementation of effectiveness and survivability studies for cruise missiles. The DTED map program developed allows for computer-generated color displays of the (large) DTED data files quickly, and allows the analyst to use the computer to determine radar site locations and masking, and to plan cruise missile flight paths. A significant amount of programming assistance was provided by Andy Scheck of JHU/APL in this effort.

SANDERS, Thomas J., Professor, "DTED Map Program Documentation," Johns Hopkins University Applied Physics Laboratory Document NSW-91-168, August 1991.

This paper provides documentation for the DTED map program developed by the author during the summer of 1991 at The Johns Hopkins University Applied Physics Laboratory. The program was written in the C language to display and manipulate DTED data files on a Macintosh computer. The program was intended to aid in the design and implementation of effectiveness and survivability studies for cruise missiles.

TURNER, Peter R., Associate Professor, and Craig K. BAILEY, Associate Professor, "Technical Word-processing on IBM PC's Part II: A Comparative Review of Word for Windows and Word Perfect 5.1," *College Mathematics Journal*, **22** (1991), 436-441.

In this invited software review, the relative merits of two general purpose PC word processor systems are discussed in the context of their use as technical word-processors. Both systems allow for the setting and editing of technical expressions and equations. They also permit with varying ease the inclusion of graphics produced by other programs or software packages. The hardware requirements of Word for Windows are very much greater than those of Word Perfect. The qualities of the two systems for use in preparing mathematical papers and tests are discussed and compared.

TURNER, Peter R., Associate Professor, "Implementation and Analysis of Extended SLI Operations," *Proceedings of the Tenth IEEE Symposium on Computer Arithmetic*, IEEE Computer Society, Washington, DC, pp. 118-126.

This paper is concerned with extended arithmetic operations, such as forming scalar products, in symmetric level-index (SLI) arithmetic. Schemes for the implementation of such algorithms are described and analyzed both in terms of comparative timings for these operations and their floating-point counterparts and in terms of the control of errors in the computation. It is seen that with sufficient parallelism available in the SLI processor, the computation can be as fast as for floating-point operations. Also, SLI operation can be modified to produce just a single rounding error from extended operations very economically.

TURNER, Peter R., Associate Professor, co-author, "Symmetric Level Index Arithmetic in Simulation and Modeling," *Proceedings of the Twenty-third Pittsburgh Conference on Modeling and Simulation*, **33**, 1(1992), 407-417.

This paper begins with a general introduction to the symmetric level-index (SLI) system of number representation and arithmetic. This system provides a robust framework in which experimental computation can be performed without risk of failure due to overflow/underflow or to poor scaling of the original problem. There follows a brief summary of some existing computational experience with this system to illustrate its strengths in numerical, graphical, and parallel computational settings. An example of the use of SLI arithmetic to overcome graphics failure in the modeling of a turbulent combustion problem is presented. The main thrust of this paper is to introduce the idea of

SLI-linear least squares data-fitting. The use of generalized logarithm and exponential functions is seen to offer significant improvement over the more conventional linear regression tools for fitting data from a compound exponential decay such as the decay of radioactive materials.

WARDLAW, William P., Professor, "Problem 1373," *Mathematics Magazine*, **64** (June 1991), 197.

Find the set  $S'$  of all accumulation points of the set  $S = \{\phi(n)/n : n \in \mathbb{N}\}$ , where  $\phi$  is the Euler phi function and  $\mathbb{N}$  is the set of positive integers.

WARDLAW, William P., Professor, "Problem 1384," *Mathematics Magazine*, **64** (December 1991) 350.

A square matrix  $M$  is periodic if and only if there is a positive integer  $r$  and a nonnegative integer  $s$  such that  $M^{r+s} = M^s$ . Characterize those fields  $K$  such that every square matrix over  $K$  is periodic.

WARDLAW, William P., Professor, "Problem 470," *College Mathematics Journal*, **23** (January 1992) 70.

Evaluate

$$\lim_{n \rightarrow \infty} \frac{1}{n \sin n}$$

or show that it does not exist.

WARDLAW, William P., Professor, co-author, "Solution 445," *College Mathematics Journal*, **23** (January 1992) 74-76.

A square matrix  $A$  is said to have order  $n$  if  $n$  is the least positive integer such that  $A^n = I$ , where  $I$  is an identity matrix. Let  $d_F(n)$  denote the least dimension for which there exists a matrix  $A$  of order  $n$  with elements in the field  $F$ . R. Hanson [Minimum dimension for a square matrix, *CMJ*, **21** (January 1990), 28-34] has found explicit expressions for  $d_R(n)$  and  $d_C(n)$ , namely,

$$d_C(n) = 1 \wedge d_R(n) = \begin{cases} 1, & n=1,2 \\ 2, & n \geq 3 \end{cases}$$

Find  $d_Q(n)$ . [The dimension of a  $k \times k$  matrix is  $k$ ;  $R, C$ , and  $Q$  denote the real, complex, and rational numbers, respectively.]

Let  $n = 2^a \prod_{i=1}^k p_i^{a_i} > 2$ , where  $a \geq 0$ ,  $a_i > 0$  are integers and the  $p_i$  are distinct odd primes. Then, writing  $d(n)$  for  $d_Q(n)$ ,

$$d(n) = \begin{cases} \sum_{i=1}^k (p_i - 1)p_i^{a_i-1}, & \alpha \leq 1 \\ 2^{\alpha-1} + \sum_{i=1}^k (p_i - 1)p_i^{a_i-1}, & \alpha > 1 \end{cases}$$

Also,  $d(1) = d(2) = 1$ . (An empty product or an empty sum should be interpreted as 1 or 0, respectively.)

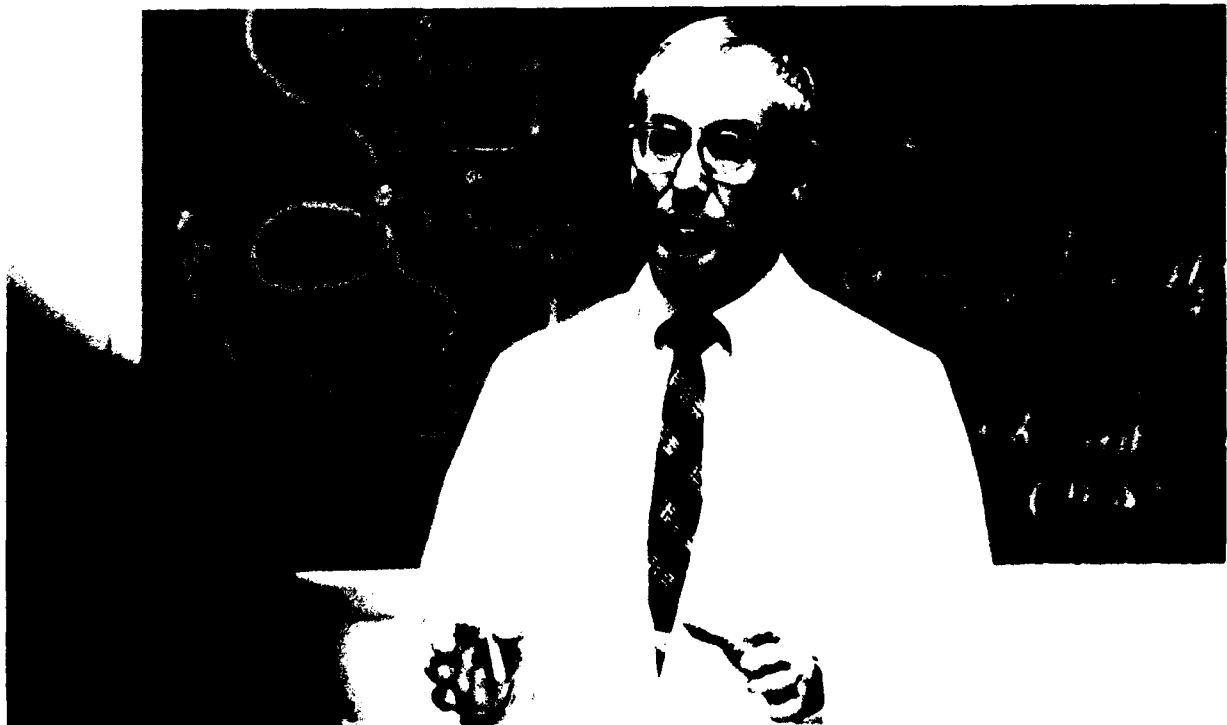
WARDLAW, William P., Professor, "The Smallest Matrix of Given Period and Primitive Roots of Unity," *Linear Algebra and Its Applications*, 160 (1992), 87-97.

A nonsingular matrix  $A$  has period  $n$  if  $A^n = I$  but  $A^k \neq I$  for  $0 < k < n$ . The researcher investigated the number  $r_K(n)$ , which is the smallest  $r$  such that there is an  $r \times r$  matrix with entries in the field  $K$ , that has period  $n$ . The researcher computed this number as a function of the common degree  $\Theta_K(j)$  of the irreducible factors of the cyclotomic polynomial  $c_j(x)$ . Thus, the researcher was led to an investigation of roots of unity in order to understand better the function  $\Theta$ .

WARDLAW, William P., Professor, *Matrix Representation of Finite Fields*, Naval Research Laboratory Report NRL/MR/5350.1 - 92-6953.

Finite fields (also called Galois fields) have been studied since their introduction by Evariste Galois in 1832 and the publication of his work in 1846. In the last few decades, finite fields have become important to information theory, coding theory, and cryptography.

This report presents a simple method for representing a finite field in terms of powers of a single matrix over the integers modulo the characteristic of the field. The addition and multiplication in the field are immediately obtained as results of ordinary matrix addition and multiplication. The representation called the canonical cyclic representation, makes it easy to understand the field structure and to carry out computations in the field.



# Presentations

BAILEY, Craig K., Associate Professor, "It's Impossible," Thomas Jefferson School for Science and Technology, Mathematics and Technology Symposium, Alexandria, Virginia, 22 April 1992.

BAKER, B. Mitchell, Associate Professor, "Connections Between Physics, Braids, and  $SU(2)$ ," Annapolis, Maryland, 27 April 1992.

CRAWFORD, Carol G., Associate Professor, "Relaxation Algorithms for Automated Fingerprint Identification," Federal Bureau of Investigation, Washington, DC, 13 September 1991.

GAGLIONE, Anthony M., Professor, "The Universal Theory of Free Groups," Special Session of the American Mathematical Society, Tuscaloosa, Alabama, 13 March 1992.

GAGLIONE, Anthony M., Professor, "On the Solution of an (Easy) Problem of Alsbar Rhemtulla," Mathematics Department, U.S. Naval Academy, Annapolis, Maryland, 24 April 1992.

GAGLIONE, Anthony M., Professor, "Lyndon's Length Function, Lambda Trees, and Logic: A Likely Linkage," W. Muluga University, Kalamazoo, Michigan, 8 May 1992.

GAGLIONE, Anthony M., Professor, "Every Universally Free Group is Tree-Free," Group Theory Conference in honor of H. Zassenhaus, Columbus, Ohio, 15 May 1992.

GARCIA, Sonia M. F., Assistant Professor, "On the Mixed Finite Element Methods for Parabolic Problems," Finite Element Meeting, Pennsylvania State University, State College, Pennsylvania, 8-9 November 1991.

GARCIA, Sonia M. F., Assistant Professor, "Numerical Methods for Partial Differential Equations," New Jersey Institute of Technology, Newark, New Jersey, 21-22 November 1991.

GARCIA, Sonia M. F., Assistant Professor, "Development of a Numerical Method for Solving the Nonlinear Parabolic System Describing the Formation of Wing Cracks in Ice," Applied Mathematics Seminar, Mathematics Department, U.S. Naval Academy, Annapolis, Maryland, 20 March 1992.

GOTAY, Mark J., Associate Professor, "Momentum Maps, Stress-Energy Tensors and the Belinfante-Rosenfeld Formula," AMS/IMS/SLAM Joint Summer Research Conference on Mathematical Aspects of Classical Field Theory, Seattle, Washington, 26 July 1991.

GOTAY, Mark J., Associate Professor, "Momentum Maps, Stress-Energy Tensors and the Belinfante-Rosenfeld Formula," Colloquium, University of Hawaii, Honolulu, Hawaii, 7 February 1992.

GOTAY, Mark J., Associate Professor, "Momentum Maps, Stress-Energy Tensors, and the Belinfante-Rosenfeld Formula," Conference on Complex Geometry and Mathematical Physics, Arkansas State University, Jonesboro, Arkansas, 26 April 1992.

GOTAY, Mark J., Associate Professor, "A Geometric Variational Construction of Stress-Energy-Momentum Tensors," Workshop on Geometric Variational Problems and Optimal Control, Fields Institute for Research in Mathematical Science, Waterloo, Ontario, Canada, June 1992.

GRANT, Caroline G., Assistant Professor, "Constructing Complete Kahler Metrics on Singular Algebraic Varieties," U.S. Naval Academy Mathematics Colloquium, Annapolis, Maryland, 15 April 1992.

HERRMANN, Robert A., Professor, "New Classical Derivations for Instantaneous Velocity and the Second Law of Motion," Maryland, District of Columbia, Virginia Section of the Mathematical Association of America Fall Meeting, Marymount University, Arlington, Virginia, 16 November 1991.

HOFFMAN, Michael E., Associate Professor, "Free Representations of 2-Groups by Signed Permutation Matrices," Special Session on Algebraic Topology, American Mathematical Society Winter Meeting, Baltimore, Maryland, 10 January 1992.

KAMMEYER, Janet W., Assistant Professor, "Joinings and Isomorphisms of Bernoulli Processes," Tufts University Ergodic Theory Seminar, Boston, Massachusetts, 25 October 1991.



## MATHEMATICS

KAMMEYER, Janet W., Assistant Professor, "An Introduction to Restricted Orbit Equivalence," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 19 February 1992.

KAPLAN, Harold M., Professor, "Experience Teaching Dwass's Method to Absolute Beginners," Mid-Atlantic Region Probability and Statistics Day, University of Maryland Baltimore County, Catonsville, Maryland, 9 November 1991.

KONKOWSKI, Deborah A., Associate Professor, "The Stability of Non-Scalar Curvature Singularities," Spring Meeting of the American Physical Society, Washington, DC, 21 April 1992.

KONKOWSKI, Deborah A., Associate Professor, "The Stability of Singularities and Cauchy Horizons in General Relativistic Spacetimes," Cosmic Censorship Workshop, Aspen Center for Physics, Aspen, Colorado, 9 June 1992.

LOCKHART, Robert, Associate Professor, "On the Essential Spectra of Laplaceans," American Mathematical Society Summer Meeting, Orono, Maine, 7 August 1991.

MALEK-MADANI, Reza, Associate Professor, "Some Stability Theorems in Thermo-Visco-Elasticity," Partial Differential Equations Seminar, Brown University, Providence, Rhode Island, 18 October 1991.

MALEK-MADANI, Reza, Associate Professor, "Some Examples of Shear Localization in Continuum Mechanics," Shear Band Workshop, Center for Nonlinear Analysis, Carnegie Mellon University, Pittsburgh, Pennsylvania, 17 March 1992.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "Introduction to UNIX," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 30 October 1991 and 24 February 1992.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "Introduction to the Mathematics Department Computer Systems," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 12 September 1991 and 27 January 1992.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "Disk Operating Systems," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 19 September 1992 and 3 February 1992.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "QUATTRO PRO and Applications of Spreadsheets," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 26 September 1992 and 10 February 1992.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "Introduction to the Use of the Math Department Network," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 20 October 1991 and 2 March 1992.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "SUN Windowing Systems," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 7 October 1991 and 9 March 1992.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "Classroom Uses of Mathematica," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 31 October 1991 and 16 March 1992.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "A Technical Word Processor: Publisher," Mathematics Department Computer Seminar, U.S. Naval Academy, Annapolis, Maryland, 14 November 1991 and 23 March 1992.

MCCOY, Peter A., Professor, "Expansions of Analytic Functions of One Complex Variable and Their Singularities," Applied Mathematics Seminar, Mathematics Department, U.S. Naval Academy, Annapolis, Maryland, 10 October 1991.

MCCOY, Peter A., Professor, "Modeling a Free Boundary Value Problem; Hele-Shaw Flow," Mathematical Association of America Regional Meeting, Marymount University, Arlington, Virginia, 15 November 1991.

MCCOY, Peter A., Professor, "Applications of Function Theoretic Methods in Partial Differential Equations," American Mathematics Society Ninety-eighth annual meeting Special Session on Function Theoretic Methods in Partial Differential Equations, Baltimore, Maryland, 11 January 1992.

MCCOY, Peter A., Professor, "Interpolation of Solutions to a Class of Elliptic Partial Differential Equations," Applied Mathematics Seminar, U.S. Naval Academy, Annapolis, Maryland, 6 April 1992.

MCCOY, Peter A., Professor, "What is Artificial Life," Mathematical Association of America Regional Meeting, University of Virginia, Charlottesville, Virginia, 25 April 1992.

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MEYERSON, Mark D., Professor, "Basic Net Linda," Parallel Processing Seminar, U.S. Naval Academy, Annapolis, Maryland, 4 October 1991.

MEYERSON, Mark D., Professor, "Advanced Net Linda," Parallel Processing Seminar, U.S. Naval Academy, Annapolis, Maryland, 8 November 1991.

MICHAEL, T. S., Assistant Professor, "An Application of Linear Algebra to Graph Theory," Mathematics Department Colloquium, The George Washington University, Washington, DC, 13 March 1992.

MICHAEL, T. S., Assistant Professor, "Schwenk and Beyond," Mathematics Department Colloquium, United States Naval Academy, Annapolis, Maryland, 27 April 1992.

MICHAEL, T. S., Assistant Professor, "Lower Bounds for Graph Domination by Degrees," Seventh International Conference on Graph Theory, Combinatorics, Algorithms, and Applications, Kalamazoo, Michigan, 1-5 June 1992.

NAKOS, George, Assistant Professor, "Introduction to Grobner Bases," Symbolic Astrodynamics by Computer, Annapolis, Maryland, 7 August 1991.

NAKOS, George, Assistant Professor, "Grobner Bases Using Mathematics," Symbolic Astrodynamics by Computer, Annapolis, Maryland, 8 August 1991.

PENN, Howard L., Professor, "MPP, Software for the Teaching of Calculus," Mathematical Association of America Summer National Meeting, Orono, Maine, 8 August 1991.

PENN, Howard L., Professor, "Reform in the Teaching of Engineering Calculus," National Council of Teachers of Mathematics Regional Meeting, Baltimore, Maryland, 1 November 1991.

PENN, Howard L., Professor, "MPP3D Surface Plotting Software," Mathematical Association of American Sectional Meeting, Arlington, Virginia, 16 November 1991.

PENN, Howard L., Professor, "Visualization of Applications of Calculus and Differential Equations," Mathematical Association of America Sectional Meeting, Charlottesville, Virginia, 11 April 1992.

PIERCE, John F., Associate Professor, "Singularity Theory, Pseudo-Rigid Bodies and Symmetry-Breaking Loads," Second International Congress of Industrial and Applied Mathematics, Washington, DC, 11 July 1991.

PIERCE, John F., Associate Professor, "Image Enhancement for Tele-Operated Robotic Systems," American Society for Engineering Education/National Aeronautics and Space Administration Goddard Summer Research Program, Greenbelt, Maryland, 24 July 1991.

PIERCE, John F., Associate Professor, "Orbits of Equilibria for Pseudo-Rigid Bodies," Seminar on Applied Mathematics, U.S. Naval Academy, Annapolis, Maryland, 20 October 1991.

PIERCE, John F., Associate Professor, "Transversely-Isotropic Pseudo-Rigid Materials: A Representation Theory," Department of Engineering, University of Pisa, Pisa, Italy, 12 May 1992.

PIERCE, John F., Associate Professor, "Stoppelli's Problem for Pseudo-Rigid Bodies: A Geometric Perspective," Department of Engineering, Polytechnic University, Milan, Italy, 20 May 1992.

PRICE, Geoffrey L., Associate Professor, "Algebras Associated with Shift Register Sequences," Colloquium, U.S. Naval Academy, Annapolis, Maryland, 25 September 1991.

PRICE, Geoffrey L., Associate Professor, "Index Theory for Continuous Semigroups of Endomorphism," Seminar, University of Iowa, Ames, Iowa, 12 March 1992.

PRICE, Geoffrey L., Associate Professor, "Binary Shifts on the Hyperfinite  $II_1$  Factor," Northeastern Operator Algebra Conference, West Chester, Pennsylvania, 21 March 1992.

PRICE, Geoffrey L., Associate Professor, "Binary Shifts on the Hyperfinite  $II_1$  Factor," Miniconference on  $C^*$ -Algebras and Related Topics, College Park, Maryland, 3 May 1992.

PRICE, Geoffrey L., Associate Professor, "Binary Shifts on the Hyperfinite  $II_1$  Factor," Seminar, Dartmouth College, Hanover, New Hampshire, 27 May 1992.

QUINT, Thomas, Assistant Professor, "Lattices and Two-Sided Matching Markets," International Conference on Game Theory, Stony Brook, New York, 17 July 1991.

QUINT, Thomas, Assistant Professor, "The Shapley Value of Resale-Proof Trades," International Conference on Industrial and Applied Mathematics, Washington, DC, 9 July 1991.

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QUINT, Thomas, Assistant Professor, "Linear Programming, the Assignment Game and the Permutation Game," U.S. Naval Academy Applied Mathematics Seminar, Annapolis, Maryland, 8 October 1991.

QUINT, Thomas, Assistant Professor, "Lattices and Two-Sided Matching Markets," Economics Department Seminar, Vanderbilt University, Nashville, Tennessee, 17 March 1992.

STUCKER, Aaron I., Assistant Professor, "Group Problem Solving," Mathematics Association of America (MAA) Section Meeting, University of Virginia, Charlottesville, Virginia, 25 April 1992.

STUCKER, Aaron I., Assistant Professor, "Geometry and The Earth," Benjamin Banneker Black Honors Mathematics Society, U.S. Naval Academy, Annapolis, Maryland, 20 March 1992.

STUCKER, Aaron I., Assistant Professor, "Techniques of Problems Solving," U.S. Naval Academy Summer Seminar, Annapolis, Maryland, 11 June 1992.

TURNER, Peter R., Associate Professor, "Implementation and Analysis of Extended SLI Operations," ARITH 10, the Tenth IEEE Symposium on Computer Arithmetic, Grenoble, France, 26-28 June 1991.

TURNER, Peter R., Associate Professor, Chairman and Organizer, Minisymposium on "SLI Arithmetic: An Alternative to Floating-point," International Conference on Industrial and Applied Mathematics (ICIAM) 91, Washington DC, 16 July 1991.

TURNER, Peter R., Associate Professor, "SLI Arithmetic 2: Implementation," ICIAM 91, Washington DC, 16 July 1991.

TURNER, Peter R., Associate Professor, "SLI Arithmetic 3: Impact on Numerical Algorithms," ICIAM 91, Washington DC, 16 July 1991.

TURNER, Peter R., Associate Professor, "SLI Arithmetic 4: Software Engineering Aspects," ICIAM 91, Washington DC, 16 July 1991.

TURNER, Peter R., Associate Professor, "A History of the Lords of Number Crunching," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 20 November 1991.

TURNER, Peter R., Associate Professor, "The

Leading Digit Mystery and Its Implications for Computer Design," Sigma Xi Society, U.S. Naval Academy, Annapolis, Maryland, 15 January 1992.

TURNER, Peter R., Associate Professor, "Level-index Arithmetic and Parallel Processing," Applied Mathematics Pro-Seminar and Mathematics Department Colloquium, Arizona State University, Tempe, Arizona, 12 March 1992.

TURNER, Peter R., Associate Professor, (with D. W. Lozier), "Symmetric Level-Index Arithmetic in Simulation and Modeling," Twenty-third Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 30 April-1 May 1992.

TURNER, Peter R., Associate Professor, "Symmetric Level-Index Arithmetic: An Environment for Data Fitting," SIAM National Meeting, Los Angeles, California, 16 July 1992.

WARDLAW, William P., Professor, "Periods and Subperiods of Matrices," Maryland-District of Columbia-Virginia Section of the Mathematical Association of America Spring Meeting, University of Richmond, Richmond, Virginia, 27 April 1991.

WARDLAW, William P., Professor, "Chain Addition Cycles," Orono Mathfest, University of Maine, Orono, Maine, 8 August 1991.

WARDLAW, William P., Professor, "Chain Addition Cycles," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 6 November 1991.

WARDLAW, William P., Professor, "Chain Addition Cycles," Maryland-District of Columbia-Virginia Section of the Mathematical Association of America Fall Meeting, Marymount University, Arlington, Virginia, 16 November 1991.

WARDLAW, William P., Professor, "Minimum and Characteristic Polynomials of Low-Rank Matrices," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 26 February 1992.

WARDLAW, William P., Professor, "The RSA Public Key Cryptosystem," Mathematics Club, U.S. Naval Academy, Annapolis, Maryland, 8 April 1992.

WARDLAW, William P., Professor, "The 16 (or 15) Sliding Block Puzzle," Thomas Jefferson High School of Science and Technology annual Mathematics Day program, Fairfax County, Virginia, 22 April 1992.

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WARDLAW, William P., Professor, "Minimum and Characteristic Polynomials of Low-Rank Matrices," Maryland-District of Columbia-Virginia Section of the Mathematical Association of America Spring Meeting, University of Virginia, Charlottesville,

Virginia, 27 April 1991.

WARDLAW, William P., "Pegjump Games," American University, Washington, DC, 29 April 1992.





# Oceanography

Captain Carl B. Ihli, Jr., USN  
Chair

**A**cademic year 1991-1992 was particularly productive in terms of U.S. Naval Academy oceanographic and meteorological research. The Oceanography Department research philosophy is guided by two baseline themes: (1) maximize midshipmen involvement, while (2) employing "total quality" techniques.

Thirty-one midshipmen were directly involved in oceanographic and atmospheric research. Two students completed well-received Trident projects. In fact, the Antarctic Remote Sensing work of Midshipman Andrew S. Lomax so impressed the Scripps Institute of Oceanography, that a very rare scholarship has been offered and accepted. Nineteen students participated in the fourth summer research cruise aboard the Naval Academy's oceanographic platform, YP686. More than one-hundred oceanographic stations were completed in this four week endeavor; dynamic, biological, chemical, meteorological, and geologic data were collected and processed; state-of-the-art equipment and techniques were employed, as were ancient but effective methods and tools. Seven midshipmen presented results at professional conferences of organizations such as the American Geophysical Union and the American Meteorological Society.

In an effort to best apply its principles, considerable formal research was devoted to the "total quality" principle itself. It was found that the method requires team-work, innovation, and hard analysis of data to determine optimum areas of concentration. Maximum efficiency requires that results benefit multiple communities and agencies. Accordingly, some research has been aimed in different directions and has crossed interdisciplinary boundaries. For example, some research has addressed issues of midshipmen performance by attempting to develop better methods to teach high school students; experts in microcomputer applications have collaborated with polar remote sensing specialists; an optical expert has applied his expertise to oceanographic problems; and civilian scientists have, on several occasions, collaborated with military colleagues to combine theoretical and practical perspectives.

The department is proud of the team-work at the agency level as well. A cooperative memorandum of agreement between the Naval Academy and the National Environmental Satellite Data and Information Service (NESDIS), of the National



Oceanic and Atmospheric Administration (NOAA - Department of Commerce), was signed this year to inaugurate the Cooperative Project in Oceanic Remote Sensing (CPORS). Assets in this program include a full-time professor, a VAX 3200 with two workstations, and software for processing myriad remotely-sensed data. In addition to several faculty projects, this year CPORS was responsible for three midshipmen research projects.

A midshipmen summer research cooperative program with the Navy Research Laboratory (NRL), in Monterey, California, has been instituted. Both agencies share funding responsibility equally. This year's effort yielded a technical document that has immediate fleet application.

Both the Oceanographer of the Navy, Rear Admiral Chesbrough, and the Commander, Naval Oceanography Command, Rear Admiral Chubb, visited the Oceanography Department for the expressed purpose of evaluating the utility of USNA research for Navy-wide application. Both officers expressed positive impressions by initiating actions to further employ USNA assets.

## **Sponsored Research**

### **Shallow Water Geophysical/Geological Research**

Researcher: Assistant Professor Peter L. Guth

Sponsor: Naval Research Laboratory

Using the department's new side scan sonar and YP686, the researcher is looking at bedforms and bottom features in the Chesapeake Bay near Annapolis. During the summer cruise the area of operations will be extended to the Delaware Bay and the continental shelf. The researcher will validate the side scan data with bottom sample

grabs and through use of a remotely-operated vehicle with video camera. The researcher will look at ways to manipulate and display the results and consider how to incorporate them into the academic program. The program is currently in the planning stage.

### **Validation of the SATVIS Meteorological Range Estimation Model in the Northern Arabian Sea**

Researchers: Lieutenant Commander Gary M. Mineart, USN, and  
Midshipman 1/C Jacob C. Hinz, USN

Sponsor: Naval Research Laboratory (Atmospheric Directorate),  
Monterey, California

The Navy's SATVIS Meteorological Range Estimation Model was evaluated utilizing a subset of Advanced Very High Resolution Radiometer (AVHRR) data over the northern Arabian Sea during October 1988 through May 1989. Variations in aerosol optical depth and the ratio between AVHRR channels 1 and 2 were observed and corre-

lated with synoptic data. SATVIS meteorological ranges were compared with those using the Navy Aerosol Model. Sources of error were discussed in light of recent observations of the vertical distribution of aerosols in the troposphere. A qualitative assessment of SATVIS as a Navy Tactical Decision Aid (TDA) was attempted.

### **An Examination of Synoptic Weather Data Collected During the ERICA Field Project (Winter 1988-89)**

Researcher: Associate Professor David R. Smith

Sponsor: Naval Academy Research Council Grant (ONR)

This project investigates the meteorological phenomenon called explosive cyclogenesis--rapid intensification of low pressure systems that form along frontal systems in middle latitudes. This phenomenon generally occurs several times (approximately ten) each winter offshore of continents, especially where there are warm ocean currents such as the Gulf Stream. Such storms are responsible for strong winds and heavy precipitation along the coast, and violent waves at sea. Unfortunately, this phenomenon occurs in areas where there is a lack of adequate meteorological observations.

A major field project called the Experiment on Rapidly Intensifying Cyclones over the Atlantic (ERICA) was conducted during the winter of 1988-1989 to study this phenomenon. This project analyzes datasets collected during the ERICA field Project.

This study examines surface weather analyses and satellite imagery to identify signatures preceding intense cyclone development. The purpose is to determine synoptic scale features in the meteorological data fields that can assist weather forecasters in the prediction of explosive cyclogenesis.

Identification of such features can provide meteorologists the ability to provide Naval planners with adequate lead time to avoid the adverse weather conditions associated with such storms.

Results were presented at the American Meteorological Society Symposium on Education in January 1992.

### **Estimates of Antarctic Sea-Ice Cover and Vertical Heat Flux From Passive Microwave Data**

Researcher: Midshipman 1/C Andrew S. Lomax, USN

Advisers: Assistant Professor Peter L. Guth and

Visiting Professor Robin Williams

Sponsor: Trident Scholar Program

Changes in areal extent and concentration of sea-ice around Antarctica may serve as sensitive indicators of global warming. These parameters are routinely estimated from satellite-derived passive microwave data by applying conversion algorithms to measured brightness temperatures. A comparison study was conducted between the outputs of the three main algorithms currently in use (NASA Team, Comiso

and NORSEX) and a sea-ice model (Fine Resolution Antarctic Model). A consistent value of ice extent is predicted by all three algorithms, but significant differences occur in predictions of areal coverage and spatial distribution. These differences are quantified, and their impact on vertical heat flux estimates, especially through recurring polynyas, is assessed.

### **An Investigation into the Causative Mechanisms for Explosive Cyclogenesis over the Atlantic**

Researcher: Midshipman 1/C Susan S. Minton, USN

Adviser: Associate Professor David R. Smith

Sponsor: Trident Scholar Program

Major winter storms, characterized by heavy snow and gale force winds, that strike the east coast of the United States approximately ten times per year are associated with a phenomenon called explosive cyclogenesis. These storms, referred to as "bombs," intensify at least 2.4kPa (24 mb) over a 24-hour period. Such rapid intensification over the western North Atlantic often begins when a cold Arctic outbreak moves offshore over the warmer waters of the Gulf Stream current.

This investigation examines the role of a stable atmospheric layer, called the atmospheric lid, suggested by Green (1988) as a contributing mechanism in the rapid intensification of marine cyclones. This study examines the cyclones captured

during the Experiment on Rapidly Intensifying over the Atlantic (ERICA) field project (winter of 1989). Utilizing analysis techniques developed by Graziano and Carlson (1987), lid strengths were calculated in the areas upstream of cyclogenesis for two cases and compared with data measured for a non-explosively developing situation. These cases suggest that Green's atmospheric lid is a potential predictor for explosive development of marine cyclones, given the presence of other favorable parameters.

Results were presented at the American Meteorological Society Symposium on Weather Forecasting in January 1992 and at the American Geophysical Union Spring Meeting in May 1992.



## Independent Research

### Oceanographic Investigation of the Chesapeake Bay

Researchers: Assistant Professors Peter L. Guth and Mario E. C. Vieira, Midshipmen 1/C Clayton B. Kendrick-Holmes, Jon A. Montanaro, and Paul S. Mulligan, USN, and Midshipmen 3/C Deanna L. Adams, Desa L. Burton, John B. Downes, Michael W. Gleeson, Christian M. Horak, Heather C. Keane, Jeffrey R. Leuenberger, Christopher A. Linder, Christine M. Medel, Robert A. Messer, David J. Salmons, Kim J. Shook, David J. Taylor, Michael D. Wimer, and Heather M. Zwyrer, USN.

During the summer of 1991, the Oceanography Department conducted a military summer elective research cruise in conjunction with the Division of Professional Development. More than one hundred oceanographic stations were occupied throughout the Chesapeake Bay. Data obtained related to

physical, biological, geological, and chemical parameters. Technologically advanced instrumentation and modern techniques of data reduction were used by the midshipmen. Results of this cruise were presented to the Academic Dean and Provost and the faculty.

### The Natural Rainbow and Passive Remote Sensing

Researcher: Visiting Professor Raymond L. Lee, Jr.

This project continued research in optical remote sensing of the natural rainbow. Natural rainbows are defined as those seen in rain showers, or in water droplet sprays which have drop size spectra similar to rain showers. As demonstrated in an earlier National Science Foundation grant (number ATM-8607577), remote sensing of such geophysical phenomena can clearly tell whether existing theories are adequate, unnecessarily detailed, or inadequate to explain naked-eye observations.

Ultimately, the goal is to develop a consistent theory of the natural rainbow, which means one with a nearly uniform level of complexity from the light source to the observer. Each portion of such a theory is necessary, and the whole theory is sufficient, to account for the appearance of all natural rainbows. Earlier research showed that in order to develop such a theory, an increase in the sophistication of observations was needed. This could be accomplished by examining detailed

spectroradiometric data from natural rainbows, a task not possible with existing equipment.

The project is divided into two major parts: theoretical and experimental. The theoretical part is itself divided into two portions, the forward problem and the inverse problem. These are as follows: (1) forward problem--develop a consistent theory of the natural rainbow and use it both to circumscribe the range of possible images, and to calculate the appearance of specific bows; and (2) inverse problem--determine the information content in the variability of natural bows, and determine the meteorological circumstances that give rise to a particular bow.

The research will make comparisons between the chromaticity curves of natural and theoretical rainbows to assess whether the theory adequately circumscribes the variability of nature. In addition, selected natural bows will be used to perform inversions.

### The Correlation of Subtidal Sealevel between Tidal Stations at Montauk and Peconic Bays, New York

Researchers: Ensign Gilbert C. Niedenthal, USN, and Assistant Professor Mario E. C. Vieira

Time series of sealevel observed from January to December of 1984 at the National Oceanic Atmospheric Administration (NOAA) tide station at

Montauk, New York, and three temporary stations inside the Peconic Bays Estuary, New York, were filtered to extract the subtidal component. Corre-

lations in the time domain were determined between the Montauk subtidal record and each of the Peconic records. The correlation coefficients were very high, indicating that subtidal sealevel fluctuations inside the estuary reflect those experi-

enced at the coast. This investigation is part of ongoing research on the influence of subtidal sealevel forcing an algal bloom in Long Island embayments.

### **Comparison of El Chichon and Mount Pinatubo Eruption Clouds Using MCSST Data**

Researcher: Visiting Professor Alan E. Strong

One of the key factors in assessing the climatic impact of the Mount Pinatubo eruption of 15 June 1991 is the relative size of this eruption compared with other eruptions. This intercomparison was performed with a common measurement system--National Oceanic and Atmospheric Administration's Advanced Very High Resolution Radiometer (AVHRR) Multi-Channel Sea Surface Temperature (MCSST) data, and used earlier data following the El Chichon eruption in April 1982. Although some operational differences have occurred within the

MCSST algorithms, they are basically the same since 1982. The researcher related the negative offsets imposed on the MCSST's following each volcanic event directly corresponded to the development and dispersal of the aerosol cloud. Furthermore, these offsets were related to optical thickness measurements being made by NOAA using a different AVHRR algorithm. Careful study of these relationships reveal the total volume of the Mount Pinatubo stratospheric cloud to be nearly twice that of El Chichon.

### **Long Island Sound Study**

Researcher: Assistant Professor Mario E. C. Vieira

This project consists of compiling current meter and hydrographic data sets collected in 1988 for the Long Island Sound Study by researchers from the Marine Sciences Research Center of the State University of New York. This effort is a part of the National Estuary Program conducted by the U.S. Environmental Protection Agency. The Long Island Sound Study was conceived to protect and improve the health of the Sound's resources and the water quality upon which they rely. It is the most extensive and comprehensive effort ever undertaken to collect and analyze data in the Sound.

The circulation and physical structure of the Sound's waters are fundamental aspects of the investigation. A database is being prepared consisting of edited and reduced current, salinity, and temperature time series data. These measurements are now being analyzed with the purpose of revealing the three-dimensional distribution of the residual field of motion and mass throughout the Sound.

The research was funded by the Environmental Protection Agency at the State University of New York where the researchers was a consultant.

### **Ecosystem Dynamics of Long Island Coastal Embayments: A SUPE Study**

Researcher: Assistant Professor Mario E. C. Vieira

Great South Bay, New York, is a shallow unstratified productive estuary (SUPE) typical of the coastal lagoons dominating the eastern United States coastline. The study will evaluate the interrelationship of hydrodynamics and trophodynamics on the nature of these SUPE eco-

systems, using Great South Bay as a model. The influence of freshwater inputs and coastal water intrusions on residence time of water in the Bay will be elucidated. The impact of hydrology and flushing gradients on salinity and nutrient supplies and consequent changes to primary productivity and

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the nature of the primary producers (phytoplankton versus seagrass) will be addressed.

This five-year project has been submitted to the National Science Foundation Land-Margin Ecosystems Research Program. Other investiga-

tors are scientists at the State University of New York, Woods Hole Oceanographic Institution, the University of Maryland, and the Brookhaven National Laboratory.



## Research Course Projects

### Elemental Analysis of MOR Hydrothermal Metalliferous Sulfide Deposits by Proton Induced X-Ray Emission (PIXE)

Researcher: Midshipman 1/C James R. Pietila, USN  
Adviser: Professor Douglas W. Edsall

An elemental analysis of hydrothermal vent deposits was performed using a 1.7 MeV proton induced x-ray emission (PIXE) multi-elemental analysis instrument. The Au, Ag, Ni, Cu, Fe, Zn, and Mn concentrations of these sulfides were determined for the first time using PIXE.

The 13 samples came from sulfide-rich vent sites located at: (1) mid-Atlantic ridge, tag site (26° 45'W, 44° 49'N, 3700 M); (2) Guaymas Basin, (A)

27° 00'N, 111° 24'W, 2000 M; (B) 27° 36'N, 111° 29'W, 2000 M; (3) Eastern Pacific rise (20° 49'N, 109° 06'W, 2000-2200M); and (4) Eastern Pacific rise (09° 49'N, 104° 18'W, 2520 M).

In each sample Fe, Cu, and Zn were present in high concentrations. Au, Ag, Zr, Co, and other elements were detected in trace amounts. Work is continuing to understand and apply these results to continuing geological investigations.

### Pixe Elemental Analysis of Oyster Shells

Researchers: Midshipmen 1/C Amy G. Delavan and  
Julie L. Wolfgram, USN  
Adviser: Professor Douglas W. Edsall

Oyster shells from different Chesapeake Bay regions were analyzed using the particle-induced x-ray emission method (PIXE) to determine the concentrations of individual elements present in the shells.

Metals present in all of the samples included Zn, Mg, and Fe. Also present were trace amounts of Pb and Ba. In one sample from the St. Mary's River,

trace amounts of As were detected and attributed to salt-treated pilings on the pier adjacent to the sampling site.

Much of the detected elemental concentrations are due to manufacturing, industry, and daily human activity. Work continues to determine differences between geographic areas with time and to understand the process of intake and accumulation.

### Phosphate Loading in Carr Creek

Researcher: Midshipman 1/C Daniel E. Stimpson, USN  
Adviser: Professor John W. Foerster

Nutrient loading from fertilizer runoff and sewage effluent causes severe eutrophication in the Chesapeake estuary. The Annapolis Naval Station sewage treatment plant processes approximately 475 thousand cubic meters of residential sewage annually. This effluent discharges directly into the

Chesapeake Bay and affects the nutrient budget of Carr Creek. Water and sediment samples from Carr Creek were measured for inorganic phosphate concentration. The samples revealed phosphate levels high enough to stimulate excessive algal growth.

## **Validation of Satellite SST Data for Use in Determining Coral Bleaching Sites off Bermuda**

Researcher: Midshipman 1/C David M. Ivezic, USN

Adviser: Visiting Professor Alan E. Strong

In 1988, a coral bleaching event took place in the coral-reef off the coast of Bermuda. The coral expelled the symbiotic zooxanthellae that lived in their outer, soft tissues, and this caused the coral to die. The coral bleaching had potentially devastating effects on the entire coral-reef community, which, in turn, could have devastated the entire area's ecosystem. Scientists observed a warm trend in the waters of the Caribbean and associated the anomalous warm water with the coral bleaching event.

This research was performed to determine the effectiveness of remote sensing in locating possible coral bleaching sites. Coral bleaching was researched to determine a correlation between

bleaching events and high surface water temperatures. Time series satellite data in the form of Advanced Very High Resolution Radiometer/Multi-Channel Sea Surface Temperature (AVHRR/MCSST) was then correlated with buoy and ship-board measurements off the coast of Bermuda. Due to scattering and absorption in the atmosphere from both water vapor and aerosols, the satellite data correction programs are always questionable. If there were a consistent offset in the satellite reading, corrections to the data could be made, and future use of AVHRR/MCSST data to find potential coral bleaching sites would be validated and improved.

## **Determination of Coral Reef Bleaching Sites in the Great Barrier Reef using AVHRR/MCSST Data**

Researcher: Midshipman 1/C David Lum, USN

Adviser: Visiting Professor Alan E. Strong

The purpose of this study is to determine if Advanced Very High Resolution Radiometer/Multi-Channel Sea Surface Temperature (AVHRR/MCSST) data may be used to determine existing or potential sites of coral bleaching in the Great Barrier Reef (GBR). At the end of the study, it was revealed that a strong time correlation

occurs between high sea surface temperatures (above 30 C) in the GBR in 1987 and the massive coral bleaching event observed in the GBR that year. However, much more field data on recent bleaching episodes are required in order to confirm the reliability of using SST data to find coral bleaching sites.

## **Comparison of Mount Pinatubo's Aerosol to El Chichon's Aerosol and How They Both Had an Impact on the Earth's Atmosphere**

Researcher: Midshipman 1/C April S. Cooper, USN

Adviser: Visiting Professor Alan E. Strong

Mount Pinatubo, a volcano in the Philippines near Clark Air Force Base, erupted after 600 years of silence in June of 1991 and is now believed to be the largest volcanic eruption of the century. It formed a cloud of dust and sulfuric ashes thick enough to lower average temperatures near the

equator by approximately four degrees Fahrenheit and worldwide temperatures by one degree Fahrenheit (Stowe, Carey, and Pellegrino 1991). The cloud has circled the entire globe and is about fifteen miles above the equator.

## Publications

FOERSTER, John W., Professor, "Northeast North Pacific Spring Zooplankton Pattern," Johns Hopkins University Applied Physics Laboratory Report RS-91-270, November 1991.

An intensive short-term study of zooplankton in the northeast North Pacific Ocean occurred in April of 1989. Sampling was done over 330,000 square kilometers down to a depth of 125 m. The sampling system used two simultaneously towed devices. One system deployed a dual narrow beam sonar system (38 kHz, 200kHz). Another device sampled the oceanographic parameters of conductivity, temperature, depth, and chlorophyll a continuously as it undulated from near the surface to 125m. Sensed data were recorded digitally, along with continuously updated satellite navigation positions. Surveys for zooplankton occurred at night for 10-12 hours at speeds between 8-10 knots. Twice daily the ship stopped for vertical stations.

The information collected was for species identification. The purpose of the study was to map an area of the ocean in as synoptic a fashion as possible. The hypothesis tested was that multidimensional distribution (patchiness, diffusion, layering) is mapped adequately by acoustic techniques. Zooplankton data are compared to oceanographic measurements and water masses. Layers are identified with the horizontal and vertical distributions.

FOERSTER, John W., Professor, "Mixed Layered Spring Bioluminescence Patterns in the Northeast North Pacific Ocean," Johns Hopkins University Applied Physics Laboratory Report RS-91-229, September 1991.

Oceanographic observations and analyses use a variety of tools. In this instance, bioluminescence becomes a way to mark changes in the water masses in the Northeast North Pacific Ocean (NENPO). The hypothesis is that multidimensional plankton distribution (patchiness, diffusion, layering) in the NENPO is a function of water mass interaction. These water masses are part of the North Pacific geostrophic flow and interact in an area where easterly flowing currents become eastern boundary currents. The water masses include the West Wind Drift, the Aleutian Current, Davidson Current, and a frontal zone. A major suite of sensors (conductivity, temperature, depth, chlorophyll a, and bioluminescence) deploys on a towed vehicle. This vehicle undulates from near the surface to 150 meters, as the ship moves ahead at 8-10 knots. All tows are 10-12 hours in length and done at night for

21 days. Twice daily, the ship stops for vertical profiling and collection of plankton at the levels of major bioluminescence and chlorophyll a activity. The most numerous dinoflagellate at levels of peak production is *Peridinium cerasus*. Details of the data analysis show distinct vertical and horizontal distributions of the plankton in the frontal zone, and the three water masses. Correlation of bioluminescence activity and chlorophyll a is indicative of circulation and biotal activity in the water masses. The hypothesis is acceptable.

GUTH, Peter L., Assistant Professor, co-author, "Microcomputer Techniques and Applications--Microcomputer Software for Structural Geologists," *Journal of Structural Geology*, 13 (1991), 1079-1084.

Many programs of interest to field and structural geologists have been written for both Macintosh and MS-DOS microcomputers. The researcher has examined the characteristics of good programs related to the storage and management of structural data, display and analysis of orientations, analysis of strain in brittle and ductile rocks, and modelling of folded and faulted strata.

GUTH, Peter L., Assistant Professor, and David A. WALTZ, Lieutenant Commander, NOAA, "Combining GPS with Government Digital Cartographic Data," *Proceedings of the U.S. Hydrographic Conference, Fifth Biennial National Ocean Service International Hydrographic Conference*, pp. 119-123.

A program was developed to combine a global positioning satellite (GPS) receiver with digital cartographic data available at low cost from Federal government agencies. The program currently uses three databases from the National Ocean Service, Defense Mapping Agency, and Census Bureau. The user selects a map projection and scale, and the program draws a map on the screen. The program then plots the position reported by the GPS receiver. This system uses the data sets for purposes beyond their design criteria, and enlarged to scales for which they were not intended, but still provides a valuable tool.

This system was developed for automatically supplying accurate locations for scientific data collections. The system was also used to monitor the ship's position at anchor; GPS provides positions during storms when radar and visual fixes become impossible: GPS also allows rapid verification that the anchor is not dragging.

LEE, Raymond L., Jr., Visiting Assistant Professor, "What are 'All the Colors of the Rainbow'?" *Applied Optics*, 30 (20 August 1991), 3401-3407.

Both folklore and theory imply that naturally occurring rainbows display a wide range of nearly pure colors. However, digital image analysis of color slides shows that the natural rainbow's colors are not especially pure and that the bow's background causes much of this desaturation.

MINEART, Gary M., Lieutenant Commander, USN, and Jacob C. HINZ, Midshipman 1/C, USN, "Validation of the SATVIS Meteorological Range Estimation Model in the Northern Arabian Sea," USNA-NOARL Midshipman Summer Training Summary Report, June 1991, and Naval Oceanographic and Atmospheric Research Laboratory Technical Note-190, November 1991.

The Navy's SATVIS Meteorological Range Estimation Model was evaluated utilizing a subset of Advanced Very High Resolution Radiometer (AVHRR) data over the northern Arabian Sea during October 1988 through May 1989. Variations in aerosol optical depth and the ratio between AVHRR channels 1 and 2 were observed and correlated with synoptic data. SATVIS meteorological ranges were compared with those using the Navy Aerosol Model. Sources of error were discussed in light of recent observations of the vertical distribution of aerosols in the troposphere. A qualitative assessment of SATVIS as a Navy Tactical Decision Aid (TDA) was attempted.

STRONG, Alan E., Visiting Professor, co-author, "Comparison of Aerosol Layers from Mount Pinatubo and El Chichon with NOAA/AVHRR Data," *EOS*, 12 (October 1991), 95.

In this paper, derived values of aerosol optical thickness are compared with reflectance data from Advanced Very High Resolution Radiometer (AVHRR). In the case of El Chichon, a single-scattering algorithm is used to estimate optical depth, using the reflectance in the two shortest wavelength channels to estimate the effects of particle size on the scattering phase function. In the case of Mount Pinatubo, a multiple-scattering algorithm is used to estimate optical depth using the shortest wavelength reflectance channel with a priori particle size distribution determining the phase function. These will be compared with the spatial and temporal distribution of the aerosol layer as monitored by the anomalies in remotely-sensed sea

surface temperature by AVHRR for the two eruptions.

The relative differences between the two reflectant algorithms will be evaluated by comparison with sun-photometer aerosol optical thickness observations co-located with Advanced Very High Resolution Radiometer reflectance data. These differences will be accounted for in the estimation of the difference between the optical thickness of the aerosol layer produced by these two eruptions.

SMITH, David R., Associate Professor, Caren M. RITTER, Ensign, USN, and Alan E. STRONG, Visiting Professor, "An Examination of Sea-surface Temperature Influence on Tropical Storms over the Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea," *Proceedings of the Sixth Conference on Satellite Meteorology and Oceanography*, Atlanta, Georgia, 5-10 January 1992, pp. 89-92.

The present research, performed at the Center for Excellence in Oceanic Remote Sensing (CEORS) at the United States Naval Academy, examined hurricane data collected during the 1982-1989 hurricane seasons, as well as May-December Sea Surface Temperature (SST) values over this same period. The researchers attempt to correlate the prevailing (SST) patterns with the development and movement of hurricanes that occurred in the Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea.

STRONG, Alan E., Visiting Professor, "Sea Surface Temperature Signals from Satellites," *Encyclopedia of Earth System Science*, ed. W.A. Nierenberg, San Diego, Academic Press, Vol. 4, (1992), pp. 69-80.

Satellite-derived observations of sea surface temperatures (SSTs) have been used routinely during the past 10 years to provide a more complete monitoring of the planet's oceans. The more conventionally derived SSTs from ship and buoy platforms provide an important satellite validation for maintaining accuracy in this increasingly used remote-sensing measurement have provided a valuable record during the past few centuries that has been admittedly incomplete, especially over the southern hemisphere. With the inclusion of operational satellite multi-channel SST (MCSST) observations, the oceans can be better monitored, as researchers watch and wait for any signs of global warming and further changes in global climate over the next few decades.

STRONG, Alan E., Visiting Professor, "Monthly Time-Series of Coincident in-situ SST and MCSST," *EOS*, 72 (December 1991), 74.

For the past ten years, multi-channel sea surface temperatures from NOAA satellites have been produced operationally. Considerable debate has focussed on the accuracy of the operational algorithms used by NOAA and the ability both to adequately remove water vapor and address occasional episodes of global or regional aerosol contamination. Most of these examinations have centered on individual retrievals and match-ups with drifting buoy observations.

This study examines monthly mean coincident grid-point data from 1984-1990. These data have been separated hemispherically, latitudinally, and by ocean basin to conventional and satellite Sea Surface Temperature (SST). For a grid-point to be considered for a coincident measurement, both one monthly mean satellite SST observation and at least five in-situ SST grid values must be available. The 1982-1983 "El Chichon" years were omitted from this study.

Global and hemispherical, average differences (biases) during the seven-year period are small for the regions employed, never exceeding 0.1 degree C. The standard error of estimate, although a bit larger, is well below the individual match-up accuracies ( $\pm 0.7$  degreeC) from drifting buoys. Most important, no trend is found in these slight differences observed during the period.

Overall, the global summary finds good agreement between satellite and conventional SSTs. As the regions become smaller, the monthly, and especially seasonal, variabilities become noticeably larger. Some of these seasonal variations may be revealing ship-induced heating at high latitude during winter.

VIEIRA, Mario E. C., Assistant Professor, co-author, "Near-Inertial Motion on the Shelf/Slope Front off Northeast Spain," *Journal of Geophysical Research*, 97, C5 (1992), 7277-7281.

Near-inertial motion on the shelf/slope front off northeast Spain was monitored using surface drifters and moored current meters. On the shelf, strong inertial currents were generated by a wind burst. The inertial current amplitude was about 70 cm/s at the surface, 30 cm/s at the base of the mixed layer, and 10 cm/s in the interior. The observed near-inertial frequency on the shelf was about 10% lower than the local inertial frequency, suggesting that the

near-inertial motion was embedded in region of strong anticyclonic shear. Also, the phase of near-inertial motion increased through the water column, indicating that the energy propagation was downward. By contrast, the surface inertial currents were only 10 cm/s in the center of the shelf/slope front. Indirect evidence suggests that the observed small surface inertial currents were the result of rapid downward transfer of near-inertial energy in the front.

WILLIAMS, Robin G., Visiting Professor, co-author, "Ice Flexure Forced by Internal Wave Packets in the Arctic Ocean," *Science*, 254 (1991), 832-835.

Tiltmeters on the Arctic Ocean were used to measure flexure of the ice forced by an energetic packet of internal waves riding the crest to diurnal internal bores emanating from the Yermak Plateau, north of the Svalbard Archipelago. The waves forced an oscillatory excursion of 36 microradians in tilt of the ice, corresponding to an excursion of 16 micrometers per second in vertical velocity at the surface and of 3.5 millimeters in surface displacement. Strainmeters embedded in the ice measured an excursion of  $3 \times 10^{-7}$  in strain, consistent with ice flexure rather than compression. The measured tilt is consistent with direct measurements of excursions in horizontal current near the surface (12 centimeters per second) and in vertical displacement (36 meters) of the pycnocline 100 meters below the surface.

WILLIAMS, Robin G., Visiting Professor, co-author, "A Progress Report," *Arctic Research* (Fall 1991).

During the period September 1988 to May 1989 the Coordinated Eastern Arctic Research Experiment (CEAREX) was staged. This field program, sponsored principally by the Office of Naval Research, involved over two-hundred scientists and technicians from seven countries. The objectives of the program were to obtain a better understanding of the structure and function of mesoscale to small-scale processes in the Arctic Ocean inlet region near Svalbard and the associated ambient acoustic noise field. This paper is a progress report on the data analysis one-and-a-half years after the completion of the field program (See *Arctic Research of the United States*, Fall 1988, p. 44; Spring 1989, p. 14, and Spring 1990, p. 55, for prior reports).



## Presentations

GUTH, Peter L., Assistant Professor, and David A. WALTZ, Lieutenant Commander, National Oceanic and Atmospheric Administration, "GPS with Government Digital Cartographic Data," U.S. Hydrographic Conference, Fifth Biennial National Ocean Service International Hydrographic Conference, Baltimore, Maryland, 26 February 1992.

MINTON, Susan S., Midshipman 1/C, USN, and David R. SMITH, Associate Professor, "The Contribution of the Atmospheric Lid Condition to the Explosive Development of Cyclones During the ERICA Field Project," 1992 Joint Spring Meeting of the American Geophysical Union, Montreal, Quebec, Canada, 12 May 1992.

RITTER, Caren M., Ensign, USN, David R. SMITH, Associate Professor, and Alan E. STRONG, Visiting Professor, "A Reexamination of Sea-surface Temperature as a Predictor for Tropical Storm Intensity," Sixth Conference on Satellite Meteorology and Oceanography, American Meteorology Society, Atlanta, Georgia, 3-8 January 1992.

RITTER, Caren M., Ensign, USN, David R. SMITH, Associate Professor, and Alan E. STRONG, Visiting Professor, "A Discussion of the Educational Initiatives of the American Meteorological Society," Fortieth National Convention of the National Science Teachers Association, Boston, Massachusetts, 27 March 1992.

SMITH, David R., Associate Professor, "American Meteorological Society's Project Atmosphere: K-12 Educational Initiatives for Meteorology," Maryland Pilot Earth Science and Technology Network (MAPS-NET) Workshop, Morgan State University, Baltimore, Maryland 10 July 1991.

SMITH, David R., Associate Professor, co-author, "Atmospheric Science Education Program for Teachers: Developing Partnerships between Schools, Colleges, and Governmental Agencies," Soviet/American Science Education Conference, Moscow State University, Moscow, Soviet Union, 27 July - 7 August 1991.

SMITH, David R., Associate Professor, "An Overview of the AMS Pre-college Education Program," Twenty-first Conference on Broadcast Meteorology, American Meteorology Society, Crystal City, Virginia, October 1991.

SMITH, David R., Associate Professor, Paul I. BOWEN III, and Keith LEHNHARDT, Ensigns, USN, and Susan S. MINTON, Midshipman 1/C, USN, "The Atmospheric Lid as a Precursor of Explosively Developing Marine Cyclones," Symposium on Weather Forecasting, American Meteorology Society, Atlanta, Georgia, 3-8 January 1992.

SMITH, David R., Associate Professor, "The Atmospheric Education Resource Agents Program of the American Meteorological Society: Developing Partnerships for K-12 Science Education with Leadership Training for Teachers," American Meteorology Society Symposium on Education, Atlanta, Georgia, 3-8 January 1992.

STRONG, Alan E., Visiting Professor, "Coral Bleaching and High Sea Surface Temperatures," National Oceanic Atmospheric Administration Coral Bleaching Workshop, Miami, Florida, 24-25 June 1991.

STRONG, Alan E., Visiting Professor, David R. SMITH, Associate Professor, and Caren M. RITTER, Ensign, USN, "An Examination of Sea-surface Temperature Influence on Tropical Storms over the Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea," Sixth Conference on Satellite Meteorology and Oceanography, Atlanta, Georgia, 5-10 January 1992.

STRONG, Alan E., Visiting Professor, "Monthly Time-Series of Coincident in-situ SST and MCSST," American Geophysics Union Ocean Sciences Conference, New Orleans, Louisiana, 27-31 January 1992.

STRONG, Alan E., Visiting Professor, "Current and Future Satellite Optical and Infrared Sensors for Environmental Monitoring," Electro-Optical and Infrared Systems Conference (Technical Marketing Society of America), Orlando, Florida, 27 March 1992, and Tysons Corner, Virginia, 10 April 1992.

VIEIRA, Mario E. C., Assistant Professor, "Plume Dispersion of Dilute Suspensions: A Model of Barge Overflow Adapted for Use in a Personal Computer," Conference of the International Association of Water Pollution Research and Control, Lisbon, Portugal, 20-22 November 1991.

VIEIRA, Mario E. C., Assistant Professor, "On the Subtidally Driven Flushing of the Peconic Estuary," Meeting of the Atlantic Estuarine Research Society, North Topsail Beach, North Carolina, 9-11 April 1992.

WILLIAMS, Robin G., Visiting Professor, Andrew S. LOMAX, Midshipman 1/C, USN, and Peter L. GUTH, Assistant Professor, "Estimates of Antarctic Sea-Ice Cover and Vertical Heat Flux from Passive Microwave Data," American Geophysics Union Conference, Montreal, Quebec, Canada, 12-15 May 1992.





## Physics

Professor Robert N. Shelby  
Chair

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The 1991-1992 academic year has been another year of active and productive involvement of Physics Department faculty and students in a broad range of research efforts. As detailed in the abstracts that follow, the range of topics researched includes studies of planetary magnetic fields, galactic astronomy, atomic physics, nuclear physics, archaeological research, condensed matter physics, non-linear optics, optics and lasers, submarine magnetics, non-linear acoustics and acoustical signatures. Continuing improvements in major systems have greatly enhanced experimental research capabilities in the optics, atomic physics, acoustics, condensed matter and nuclear physics laboratories. These efforts, together with continuing laboratory development, computer interfacing work, and software development for student and research laboratories, help maintain the vitality of the educational program in the department.

The long-established history of active midshipmen involvement in departmental research was continued, with three Trident Scholar Projects and nine independent student research projects having been successfully completed during the year. Highlights of the student research have included the Trident Scholar Prize being won by Midshipman 1/C Bonnie R. Roberts, a student of Associate Professor Albert, and three papers given at a national Acoustical Society meeting by students of Associate Professor Korman.

Visiting researchers in the department this year were Dr. Mike McLin, an Office of Naval Technology Postdoctoral Fellow working with Professor Fontanella in condensed matter research, and Dr. Charles Bell, who came from White Oak Laboratory as a participant in the Naval Scientist Training and Exchange Program (NSTEP).



Funding support for Physics Department research has come from departmental funds, the Naval Academy Research Council and Instructional Development Advisory Committee, the Naval Research Laboratory, the National Science Foundation, the David Taylor Research Center, the American Association of Engineering Education, and DuPont de Nemours, Co.

## Sponsored Research

### Projectile K-Auger Electron Spectroscopy in Fast Ion-Atom Collisions

Researcher: Assistant Professor John M. Anthony

Sponsor: Naval Academy Research Council (ONR)

The objective of this experimental project is to investigate fundamental processes which occur when ions contained in a high energy ion beam collide with stationary gas atoms. Auger electron emission by the excited ions is measured using a unique device known as a parallel plate tandem electron spectrometer. Until recently, study of the decay of a projectile ion moving at speeds comparable to that of the electron emitted during decay of the ion has been limited by poor resolution. Because of the projectile's motion, the Auger electron lines arising from different atomic transitions tend to blend together. The researcher's experiment utilizes deceleration and refocusing of the electrons and is capable of a factor of 10 improvement in electron energy resolution.

A large number of electron spectra have been measured and analyzed for various combinations of ion energy, target gas, and projectile. Until now, these experiments have been carried out at various laboratories across the country (Oak Ridge National Laboratory; the J. R. MacDonald Laboratory at Kansas State University; and Triangle Universities Laboratory at Duke University). The Physics Department is in the process of purchasing an electron analyzing system from the P&T Corpora-

tion of Livermore, California; it should be delivered this year. Also, funds have been reserved in the department budget for fiscal year 1993 to purchase a high vacuum chamber and beam line that will allow these experiments to be carried out on site (at the Tandem Accelerator Lab in Michelson Hall).

At present, our main interest is in Carbon and Oxygen Ions containing 4 atomic electrons ( $C^{2+}$  or Carbon with two electrons removed; and  $O^{4+}$  or Oxygen with four electrons removed). Using this experimental technique, the researcher can study various atomic processes including: (1) electron transfer from the target atom to the projectile ion (capture); (2) loss of a projectile K-shell electron (ionization); and (3) the formation of excited metastable ions during gas or foil stripping of the ion.

The collaboration between Professor Anthony and the Atomic Collision group at Kansas State University has resulted in a recent publication. Future plans include the publication of two additional journal articles, to continue measuring cross sections for other ions, and to establish an experimental program in Michelson Hall by the end of 1993.

### Doppler Shifts of Sonar Waves Scattered from Rotating Targets

Researcher: Professor Donald W. Brill

Sponsor: Johns Hopkins Applied Physics Laboratory

A study was made of the effect which a rotating target would have on its sonar return. As the target turns each feature on it will scatter a Doppler shifted return signal which depends on the reflecting feature's motion relative to the medium (water). A target was simulated by an acoustic diffraction grating made up of a set of uniformly scattering

ribs. This grating turned slowly about an axis containing the central rib which was along a direction perpendicular to the direction of propagation of the incident plane acoustic wavefronts. The incident continuous wave was back-scattered into a returned signal with a spectrum which was displayed by a "fast Fourier transform."

## **Computer Simulation of Second Stokes Scattering in Transient Raman Scattering**

Researcher: Professor Gerald P. Calame

Sponsor: Naval Research Laboratory (Code 6540)

The response of Raman-scattering media to transient laser pulses is of continuing interest for several practical applications. Recent interest has been generated in the study of the generation of the second-Stokes beam under transient conditions. A computer program, written last year in order to model the process, suffered from an inadequate number of points in the spatial mesh, and did not

simulate realistically the buildup of the first and second Stokes beams from original photon noise. The program has been rewritten in order to remove these difficulties, and is finally up and running on the CRAY. Preliminary calculations make it seem likely that the experimental results can successfully be modeled with this program.

## **A Self-Excited Low Frequency Underwater Tone Source: Phase II**

Researcher: Professor Samuel A. Elder

Sponsor: Naval Academy Research Council (OMN)

Low frequency underwater sound sources generally require large scale transducers and high-powered signal generators because of the large acoustic displacements needed to produce moderate sound levels at long wavelength. The present project is to design and test a simple low frequency sound source that can be operated without electric power by towing it through the water--in effect, a low frequency underwater whistle or organ pipe. The apparatus consists of a resonant, slotted hollow box, equipped with streamlined fairings, that produces sounds of 100 Hz or less when towed at speeds in the range 1 to 22 knots. The original design of the resonant box was based on theoretical notions gained from earlier work by the investigator on submarine flow tones, sponsored by the Naval Sea Systems Command.

In two series of tests carried out in the USNA High Speed Tow Tank in July and December of 1991, the spectra for intense breathing-mode flow tones were measured as a function of model speed and cavity mouth dimension. In this way it has been possible to track the development of nonlinear oscillation behavior and to relate it to parameters of the motion. Nonlinear oscillation seems to be correlated with the evolution of strong eddies in the boundary layer. The linear/nonlinear transition seems to be analogous to the voicing operations that are used to transform "flute" voiced organ pipes to diapason pipes, and provides some insight into the "physics" underlying the ancient art of pipe-voicing. This is the sort of information needed to produce powerful and reliable passive tone sources for underwater sonar testing.

## **Electrical Properties of Polymers**

Researchers: Professor John J. Fontanella and

Associate Professor Mary C. Wintersgill

Sponsor: Du Pont de Nemours, Co.

The effect of high pressure on audio frequency dielectric loss has been measured for various types of fluoropolymers. The activation parameters, including the activation volume, have been determined for each of the accessible relaxations.

In addition, electrical relaxation has been studied at very low temperatures (below 4.2K) for a variety of polymers. New relaxations have been found, and an attempt is being made to identify the origin of each.

## Dielectric Relaxation in High Glass Temperature NLO Polymers

Researcher: Professor John J. Fontanella  
Sponsor: Naval Air Warfare Center and  
Naval Academy Research Council (ONR)

The objective is to use dielectric relaxation techniques to investigate relaxation mechanisms in high glass transition temperature nonlinear optical

(NLO) polymers and to examine any sub-glass transition temperature relaxations found for associated loss of NLO polymers.

## Complex Impedance Studies of Ion Exchange Membranes

Researcher: Professor John J. Fontanella  
Sponsor: Office of Naval Research

The primary objective of this proposed work is to gain insight into ion motion in ion exchange membranes via complex impedance measurements. The initial effort will focus on NAFION. An attempt will be made to perform the measurements using imbedded electrodes in order to simulate the working conditions in an actual electrochemical cell. Audio frequency impedance/admittance measurements will be carried out from 10 Hz to  $10^5$  Hz in vacuum from 0.008 to 400K and at pressures up to several kilobars over the temperature range 100-400K using state-of-the-art devices. In the vicinity of room temperature, both higher (to 1

GHz) and lower (to 1 mHz) frequency measurements will be carried out. Thus, electrical transport and relaxation will be studied over a wide range of temperatures and pressures. Auxiliary measurements such as thermally stimulated depolarization current and thermal analysis measurements, including differential scanning calorimetry, thermomechanical, thermogravimetric, and dynamic mechanical relaxation studies, will also be carried out where appropriate. Optical and infrared absorption and x-ray diffraction measurements will also be performed.

## Optical Mixing in Photorefractive Materials

Researcher: Assistant Professor Steven R. Montgomery  
Sponsor: Naval Academy Research Council (OMN)

The response of the BSKNN crystal to an optical pulse train consisting of short pulses with 120 picosecond durations, 80 megahertz repetition rate, and 514.5 nm wavelength was tested using a mode-locked argon ion laser. The particular photorefractive effect studied was the self-pumped phase conjugate mirror, in which beams reflect off crystal faces and recombine with the input beam. The resulting grating produces an output beam as a result of this mixing that propagates in exactly the opposite direction as the input beam, causing the crystal to act as a sort of mirror, called a phase conjugate mirror. The self-pumped response of the crystal was found to be such that more than 20 percent of the input beam power was reflected, a

result similar to that found using continuous wave lasers. The time required for the self-pumped response, however, was found to be much shorter than the continuous wave case.

Self-pumped phase conjugation was then tested using ultrashort pulses of approximately three picoseconds duration with wavelengths from 590 nm to 690 nm. The pulses were derived from a tuneable dye laser that was synchronously pumped by the aforementioned mode-locked ion laser. Though the crystal produced a very noticeable beam fan as a result of random gratings, which constitutes evidence that the photorefractive effect is taking place, there was no self-pumped phase conjugate beam.

## Studies of Low-Light Level Raman Amplifiers

Researcher: Professor Lawrence L. Tankersley  
Sponsor: Naval Research Laboratory (Code 6540)

All the studies proposed are in support of an ongoing effort at the Naval Research Laboratory in Code 6540. Under this proposal, the current study of Raman amplification will be continued and extended. Work is planned for the following areas: (1) Low light level amplification and imaging, (2) Quantum fluctuations and Raman amplifier noise, (3) Interactions of noise and signal fields in amplifiers, (4) Amplifier dynamic effects-spatial and spectral gain narrowing, (5) Potential biological applications of low-light imaging, (6) Construction of a grating pulse compressor, (7) Modeling of light

scattering by dielectric particles, (8) Shape recognition studies directed to engine oil chip detection, and (9) Interferometric analysis of spectral effects in stimulated Raman scattering.

Patents for the following have been awarded: (1) Narrow Bandwidth Unstable Resonator Laser Cavity, September 1991, (2) Ultraviolet-Optical Isolator Utilizing the KDP Isomorphs, September 1991; and (3) Time-Gated Imaging through Dense-Scattering Materials Using Stimulated Raman Amplification, April 1992.

## Optically Detected ENDOR Measurements in III-V Semiconductors

Researcher: Professor Donald J. Treacy  
Sponsor: Naval Research Laboratory (Code 6870)

The aim of this program is to establish models for defects in III-V semiconductors. Electron-Nuclear Double Resonance (ENDOR) probes the fields, as seen by neighboring nuclei, in the immediate vicinity of a paramagnetic center. Optical detection of this signal increases the sensitivity of this technique to the level at which it is possible to obtain data on defects which do not have a sufficient concentration to be observed by traditional ENDOR methods.

The defect observed was a phosphorous atom on an indium lattice site,  $P_{In}$ , in the III-V semiconductor InP. An electron trapped at this

defect interacts with the central phosphorous atom, the four phosphorous nearest neighbor (NN) atoms, and the twelve indium next-nearest neighbor (NNN) atoms. The hyperfine parameters describing the interaction of the trapped electron with the central phosphorous and the NN phosphorous atoms have been determined.

The mechanism of the interaction of the trapped electron with the NNN indium atoms is complicated by the presence of a quadrupole interaction in addition to the hyperfine interaction. This feature is being investigated.

## Acquired Polarization Effects in Parity Non-Conservation Experiments with Polarized Targets

Researchers: Assistant Professor Jeffrey R. Vanhoy  
and Ensign Paul A. Larson, USN  
Sponsor: National Science Foundation

The effect of acquired polarization on parity non-conservation (PNC) experiments of the  $k \cdot I$  type has been considered. The initially unpolarized neutron beam acquires polarization in a polarized target due to the spin-spin interaction. This additional PNC term previously had been assumed to be small relative to the usual "thin-target" term. Using the helicity formalism and actual resonance parameters, the relevant PNC observables have been calculated for a number of cases. Most of the

examples are for  $I = 1/2$  targets; one  $I = 7/2$  case is included to demonstrate that this approach may be generalized to  $I > 1/2$ . Although for some cases the acquired-polarization term is small and may be neglected, in general the acquired-polarization term is comparable to the usual term, and may have the same or opposite signs. In extreme cases, the acquired-polarization term is orders of magnitude larger than the standard term. The lesson is clear: in this experiment one needs to know the resonance



parameters well in order to extract a reliable value of the PNC matrix element. The entrance channel mixing parameter for the p-wave resonance is the governing parameter.

Results suggest that k-I PNC experiments have additional uncertainties in interpretation as compared with the usual  $\sigma\sigma k$  PNC experiments. Since the  $\sigma\sigma k$  experiments are much easier to perform than the k-I PNC experiments, these difficulties may be considered mainly of academic interest. However, similar or related effects with

sensitive dependence on the resonance parameters may be crucial in proposed time reversal invariance tests which utilize a polarized neutron beam and a polarized target. Effects such as acquired polarization and depolarization should be considered in depth for these experiments. Test results suggest that explicit inclusion of actual resonance parameters and detailed calculation of the dependence of the experimental observables on these parameters provide additional insight into symmetry-breaking measurements.

## Collective Excitations and Fast E1 Strength in Cerium-140

Researchers: Assistant Professor Jeffrey R. Vanhoy and  
Midshipman 1/C Gerhard S. Schoenthal, USN  
Sponsor: National Science Foundation

The structure of  $N = 82$  nuclei is interesting because it provides a basis for understanding the effects seen in neighboring nuclei as neutron-pairs are added and taken away. The correct description of proton excitations in the  $N = 82$  isotones is crucial for explaining the behavior of the IBA-2 mixed symmetry excitations in the neighboring  $^{140}\text{Ba}$ ,  $^{142}\text{Ce}$ , and  $^{144}\text{Nd}$  nuclei.

Recently, comprehensive shell model calculations for the  $N = 82$  nuclei from  $^{133}\text{Sb}$  to  $^{154}\text{Hf}$  have been completed by Wildenthal. In Wildenthal's analysis, the proton  $g_{7/2}$  and  $d_{5/2}$  orbits are nearly degenerate, and both orbits are simultaneously filled as particles are added above the  $Z = 50$  shell. Good shell closure in  $^{140}\text{Ce}$  is not expected.

One experimental run during the previous year was dedicated to  $^{140}\text{Ce}(n,n'g)$ . Data have since been reduced, and the level scheme is completed for

states below  $E_x = 4.4$  MeV. There is now information on spin, branching ratios, and lifetimes for about 80 levels. Lifetimes are determined for many states, but an absence of firm spin assignments precludes calculation of transition rates in all cases. The distribution of E1, M1, and E2 strength for the 23 states with known spins and measureable lifetimes was compared with the Endt  $90 < A < 150$  compilation. The E1 distribution arises from only three levels, and statistics are limited. M1's appear about an order of magnitude faster than the Endt compilation. E2's are about the same magnitude or slightly slower.

Also collaborating on this project are Sally F. Hicks, C. R. Bennett, and E. A. Meier from the University of Dallas and M. T. McEllistrem of the University of Kentucky.

## High Pressure and Low Temperature Electrical Properties of Beta and Beta" Alumina

Researcher: Associate Professor Mary C. Wintersgill  
Sponsor: National Science Foundation

Beta and beta" aluminas have a number of interesting properties, many of which arise principally because of the ability of these materials to incorporate a very large variety of ions into their structure. Preliminary data indicate that a number of these materials exhibit electrical relaxations at very low temperatures, with the characteristics of quantum tunnelling behavior. The most likely explanation of this type of effect involves protons associated with impurity ions, as both types of

material show substantial absorption of water. Very low temperature studies, using a dilution refrigerator, will help in the investigation of these defects. High pressure studies are intended to provide information concerning the dilation effects associated with dipolar reorientation. This study is part of an extensive program of investigation of the defect structures and physical properties of beta and beta" alumina.

## Picosecond Optical Mixing in Photorefractive Materials

Researcher: Midshipman 1/C C. Andrew McCartney, USN

Adviser: Assistant Professor Steven R. Montgomery

Sponsor: Trident Scholar Program

The interaction of laser light in a photorefractive crystal forms an index grating that holds promise as a means of information storage and optical processing. The photorefractive effect has been studied predominantly using continuous wave lasers. For this study, photorefractive gratings in BSKNN were formed using ultrashort laser pulses and compared to CW results.

The objectives of this project were: (1) to build a device called an optical autocorrelator to measure the pulse duration of ultrashort laser pulses; (2) to introduce ultrashort pulses of known temporal duration into a photorefractive crystal to study two photorefractive effects, beam fanning and self-pumped phase conjugation; (3) to produce continuous wave laser output and compare the beam fanning and self-pumped phase conjugation results; and (4) to examine self-pumped phase conjugation for both the pulsed laser and continuous wave laser cases as a function of incident angle.

The beam fanning experiment was performed by measuring the power of a laser beam transmitted

through the crystal as a function of time to determine the fraction of power scattered by the randomly formed gratings that are responsible for beam fanning. The fanning experiments were carried out using a dye laser operating at wavelength 592 nm. Results indicate that the beam fanning time of the BSKNN crystal is the same in the pulsed and CW cases and depends only on the number of photons incident upon the crystal. The self-pumped phase conjugation response, measured at 566 nm, had significant differences in the two cases. The CW self-pumping signal was noisy and often had fluctuations that were periodic in nature that the pulsed self-pumping signal never exhibited. These differences are probably attributable to feedback between the crystal and the laser. It was also determined that incident angles larger than  $45^\circ$  were necessary in order to obtain the self-pumped response using pulses of three picoseconds duration, while CW light allows almost any incident angle. Longer pulses allowed a wider range of incident angles. In all cases the pulsed self-pumping was weaker than the CW self-pumping.

## Determination of Turbulent Velocities by Nonlinear Acoustic Scattering

Researcher: Midshipman 1/C James E. Parker III, USN

Adviser: Associate Professor Murray S. Korman

Sponsor: Trident Scholar Program

The scattering of sound by the nonlinear interaction of two sound beams in the presence of turbulence is used experimentally to measure the turbulent velocities generated by a submerged water jet. When two sound beams of primary frequencies  $f_{01}$  and  $f_{02}$  intersect in a region of turbulent flow, the nonlinear scattering generates sum and difference frequency components ( $f_{0+} = f_{01} + f_{02}$  and  $f_{0-} = f_{01} - f_{02}$ ) which radiate outside the interaction region. In the absence of turbulence, the crossed beams do not produce radiated sum and difference frequencies. In this experiment, two transducers emit continuous wave focused sound beams of frequencies  $f_{01} = 2.0$  MHz and  $f_{02} = 2.1$  MHz, respectively. The sound beams are arranged so that their focal points overlap and the beam axes are mutually perpendicular. A receiving transducer, located outside the interaction region, detects the scattered sum frequency ( $f_{0+} = 4.1$  MHz).

The turbulent velocities in the small interaction volume are determined from variations in the shape of the scattered sum frequency's intensity spectrum that are measured at each scattering angle. The motion of the turbulent eddies (which are responsible for the nonlinear scattering) generates a random Doppler shift of the sum frequency component, which broadens its intensity spectrum. Measurements of the average Doppler shift, rms frequency, skewness, and kurtosis of the time-averaged spectra are used to correlate the mean and turbulent velocity components along the radial and axial directions of the jet. Scattering results measured at 80 angles for each Of II scan positions across the jet are used to map out the velocity correlation coefficients of the turbulence. Results are then compared with earlier published experiments that use conventional hot wire probes to measure a similar turbulent jet flow in air.

## Investigation of a Possible Galactic Chimney

Researcher: Midshipman 1/C Bonnie R. Roberts, USN

Adviser: Associate Professor C. Elise Albert

Sponsor: Trident Scholar Program

Since the discovery in 1924 that we live in a separate star system, now known as the Milky Way Galaxy, astronomers have worked hard to understand the structure, composition, and dynamics of our galaxy. A particular puzzle in recent years has been the origin and dynamics of the interstellar gas in the halo region of the galaxy high above the visible flat stellar disk. The "chimney model" dominates current theories of the source, support, and ionization of halo gas, yet no one has actually seen a galactic chimney. The researcher selected the most likely candidate for a chimney in our galaxy and observed the candidate region with both emission and absorption spectra over a wide wavelength range. Observation time was granted to observe radio emission spectra with the 140-foot National Radio Astronomy Observatory telescope at Green Bank, West Virginia, and ultraviolet absorption spectra with the National Aeronautics and Space Administration's International Ultraviolet Explorer Satellite. These original observations, combined with previous observations in radio, optical, and ultraviolet wavelengths, provided the data for the study. The investigation took the novel approach of observing a single region in great detail at many different wavelengths in order to gain understanding of the composition, ionization, and dynamics of the halo gas in the region of a possible galactic chimney.

The observations are very dynamic and cannot be explained by a static halo model. Strong activity is accelerating material causing a separation in the velocities of highly ionized species, such as C IV, Si IV, and N V, and low ionization species, such as Fe II, S II, and Si II. The high ions, which characterize gas at temperatures around 100,000-200,000 degrees Kelvin, are falling into the galactic disk, while cooler gas seen in the low ions is predominantly flowing up out of the disk. Enhanced chromium and calcium absorption indicates dust grain destruction associated with a shocked region. Enhanced zinc abundance reveals high metallicity characteristic of gas recently recycled through a supernova. The strong feature of outflowing hydrogen and low ions is consistent with the swept up shell of a supernova remnant or could be an unrelated feature. The ultraviolet results are consistent with a very hot chimney model with a very long cooling time in which the gas would, in fact, have to be too hot to observe with current methods (perhaps one million degrees Kelvin). The returning fountain flow is seen only when the gas has cooled to the relatively cooler high ions that are observed at predominantly infalling velocities. If this local phenomenon is typical of the galaxy as a whole, then the cycling of gas between the stars in the disk and the halo must play an important role in the dynamics and evolution of the Milky Way.

## Independent Research

### Neutral Hydrogen Maps of Clouds in the Galactic Halo

Researcher: Associate Professor C. Elise Albert

Work has just begun, in collaboration with Dr. Laura Danly, Space Telescope Science Institute, on a program to map the neutral interstellar hydrogen gas distribution around the most interesting lines of sight in the galactic halo identified in previous optical, ultraviolet, and radio surveys of high latitude stars. Each case includes clouds at a variety of well-determined distances and with a wide range of both infalling and outflowing velocities. Radio maps of neutral hydrogen in emission at a wavelength of 21 centimeters were

obtained during three observing runs with the 140-foot telescope of the National Radio Astronomy Observatory during the past year. Data analysis has begun and is expected to show detailed spatial structure and extent of the halo clouds. This information will be crucial for modelling the origins of halo clouds, their interactions with the disk, and possible implications for quasar absorption lines. Observing costs have been funded by the National Radio Astronomy Observatory.

### Ti II Absorption Studies of Galactic Halo Gas

Researcher: Associate Professor C. Elise Albert

Work has just begun, in collaboration with Dr. Barry Welsh, National Aeronautics and Space Administration, and Dr. Laura Danly, Space Telescope Science Institute, on a project to study the scale height of interstellar titanium gas in the galactic halo. The density distribution of interstellar gas away from the plane of the galaxy appears to exhibit a complex behavior and evidently consists of two types of material: (1) a confined, diffuse cloud component with an exponential scale height of approximately 120 parsecs and (2) an extended, more rarified "intercloud" component, with a scale height of approximately 500 parsecs. Recent observations of trace atomic species, however, show that smaller amounts of neutral gas may extend much farther beyond the galactic disk. Ca II meas-

urements can be modelled by gas with a scale height of about 1500 parsecs and, even more surprisingly, the distribution of Ti II has yet to "turn over." This ion is particularly important, since it is a unique tracer of neutral hydrogen gas which, at such large heights, will provide information on how the underlying galactic disk vents its energy into the outer halo. The researchers have selected 12 southern hemisphere stars at distances up to several kiloparsecs above the plane and have been granted four nights of observing time at Cerro Tololo Interamerican Observatory in Chile to continue observations of distant Ti II absorption. Observing costs have been funded by the National Radio Astronomy Observatory.

### Hydrogen Profiling of Deuterium-Implanted Foils by Elastic Recoil Detection

Researcher: Professor Francis D. Correll

Apparatus for measuring the hydrogen content of materials by the elastic recoil detection (ERD) technique has been developed and installed in the Naval Academy Tandem Accelerator Laboratory (NATALY). This apparatus has been used to study

the hydrogen- and deuterium-content of several deuterium-implanted Ti foils and deposited layers of Ti on Au substrates. Three-MeV  $\text{He}^{++}$  ions were used to bombard the samples at grazing ( $15^\circ$ ) incidence, and recoiling H isotopes were detected at

a grazing exit angle ( $15^\circ$ ) in a silicon surface-barrier detector. Scattered He (and heavier recoil) ions were excluded from the detector by a  $15\text{-}\mu\text{m}$  thick Kapton foil. Energy spectra of the recoiling H isotopes, which can be related to concentration-vs-depth profiles of the isotopes in the

samples, were compared with data obtained elsewhere using secondary-ion mass spectrometry (SIMS). The results showed that the ERD measurements were capable of providing information about the hydrogen content of the implanted foils.

### Provenancing Studies of Rhyolite Tools Using PIXE

Researcher: Professor Francis D. Correll

Particle-induced X-ray emission (PIXE) is being used to study prehistoric stone tools collected from sites in southern Maryland by archaeologists at the Maryland Historical Trust. In previous work, preliminary measurements of the elemental compositions of fifty-one rhyolite tools were made using in-air PIXE, and the results were subjected to a statistical analysis to reveal similarities between the compositions of different tools. Additional measurements on those tools are in progress to

improve precision and to detect elements not studied in the original experiments. Forty-five new rhyolite samples from quarry areas in Maryland (Catoctin Mountains and South Mountain) and four new samples from North Carolina (Morrow Mountain) have been collected, and their compositions are being measured and compared to those of the stone tools to obtain more information about the probable origins of the tools.

### A New Model of Sound Production by Jets and Halfjets

Researcher: Professor Samuel A. Elder

A new model of jet/cavity coupling has been developed, based on the "air reed" concept introduced in 1980 by Yoshikawa and Soneyoshi [*J. Acoust. Soc. Jpn.* (E), 1, 3 (1980), 175-191]. This model is intended to replace the currently accepted "control volume" approach in explaining the interaction between jets and resonant cavities. In the new model, the "dividing" surface formed by the locus of the inflection point of the velocity profile of a separated shear layer is cast into a lagrangian representation. By taking successive total time derivatives of the dividing surface displacement, it is

possible to account for the forces and sources of the acoustic excitation of the pipe. The approach enables both jet-drive and halfjet-drive to be treated on the same basis. Currently the model is being investigated by simulation on a MacII desktop computer, using MATHEMATICA. This approach is able to explain aspects of the jet/cavity problem that are presently not well understood, and it is believed that it will lead to more accurate prediction of mode parameters. The first paper on the new model was published in the November 1991 issue of the *Journal of the Acoustical Society of Japan* (E).

### Magnetospheric Physics

Researcher: Associate Professor Irene M. Engle

The researcher has investigated several phases of magnetospheric physics as follows:

A model, from first principles, of the Jovian magnetosphere during a semi-inflated state, was compared with data observed during the Voyager II flyby. Two papers based on this work were recently published. Another paper has been submitted for publication, and yet another is in preparation.

The researcher also investigated the Mercury magnetospheric field, especially with a view to testing new small innovations developed for magnetospheres of other planets to the small data set of magnetometer measurements obtained for the Hermean magnetosphere.

Models, from first principles and by scaling from a function set, were compared to self-consistent,

three-dimensional global magnetospheres of Neptune, including its "Uranian" aspects.

Alternate sets of orthogonal functions for three-dimensional representation of magnetospheres for earth and other planets were compared to intrinsic planetary magnetic fields.

Observed temporal variations of magnetospheric configurations were related to proximate causes and consequential phenomena. The mechanisms for transport of particles, momenta, and energy related to the aforesaid phenomena were investigated.

### Dielectric Relaxation in Barium Fluoride

Researchers: Professor John J. Fontanella and  
Associate Professor Mary C. Wintersgill

It has been proposed that one important set of radiation detectors for the Superconducting Supercollider be constructed using barium fluoride. Preliminary studies of those detectors showed that some samples of barium fluoride exhibit undesirable radiation effects, and those effects are due to

impurities. Dielectric relaxation has been shown to be very sensitive to certain types of impurities in barium fluoride; various samples will be studied in an attempt to identify the impurity and the radiation damage mechanism.

### Images of the Great Total Solar Eclipse of 1991

Researcher: Associate Professor James R. Huddle

On 11 July 1991, a total solar eclipse occurred which was visible from locations in Hawaii, Baja California Sur, parts of mainland Mexico, and parts of Central and South America. This eclipse was noteworthy because of its long (6 minutes, 57 seconds) duration of totality and its near-zenith

location in Mexico. The investigator joined an expedition to Sayulita, Jalisco, Mexico, where he recorded photographic images of the eclipse and of Bailey's Beads, the Diamond Ring, the solar corona, and solar prominences.

### Filters for Safe Solar Observation

Researcher: Associate Professor James R. Huddle

Shade 14 green arc welders' glass and aluminized mylar films have been determined to be safe filters for viewing sunspots and partial phases of solar eclipses, either with or without a telescope [B.R. Chou, *Sky & Telescope* (August), 1981, 119]. Since Chou's result was published, a new product has come on the market for use by arc welders. Omni-View® Welding Filter Plates, manufactured by Gentex Optics, Inc., produce an orange image of the sun which is more aesthetically pleasing to some observers than either the green image from welder's glass or the blue image produced by aluminized mylar. In addition, the polycarbonate Omni-View plates are more easily cut to sizes and shapes appropriate for use as solar filters than is glass, and more resistant to scratching than aluminized mylar.

Transmission spectra of various shades of Omni-View filters will be acquired using Fourier transform spectroscopy. These spectra will be applied to solar irradiance data [S.L. Valley, ed., *Handbook of Geophysics and Space Environments*, New York: McGraw-Hill, 1985, Chap. 16]. The resulting transmitted solar spectra will be numerically integrated and corrected for demagnification by the eye's lens to determine the total solar irradiance in watts per square meter at the retina for each filter shade. These irradiances will be compared to the threshold for thermal lesion quoted in Chou's article in order to determine whether or not these filters will be safe for use in solar observation.

## Upgrade of the USNA Tandem Accelerator Laboratory

Researchers: Associate Professor James R. Huddle,  
Assistant Professor Jeffrey R. Vanhoy, and  
Professor Francis D. Correll

Upgrades to the Naval Academy Tandem Accelerator Laboratory have been developing under a long-range plan since 1989. During academic year 1991, the ion source/injector was upgraded to add a cesium-sputter ion source, giving the laboratory the capability to accelerate heavy ions as well as hydrogen and helium ions. This capability will be used for fast ion atomic physics experiments. A low-energy Si(Li) detector was installed, giving the laboratory the capability to detect and measure

x-rays with energies in the 0.2 keV to 2.0 keV energy range; this detector will be used for PIXE studies of concentrations of light elements in engineering materials.

Procurement documents have been prepared for a high-vacuum ion beam analysis system for materials analysis including light-element analysis, for a second beamline, and for a turbopumped helium leak detector. Delivery of these systems is expected during the fall of 1992.

## New Laboratory Experiments for SP324-425

Researchers: Associate Professor James R. Huddle,  
Assistant Professor Jeffrey R. Vanhoy, and  
Professors Francis D. Correll and Donald R. Treacy

A package of spectroscopy experiments for the Physics of the Atom sequence of courses for physics majors (SP324-425) is under development. The package will include experiments performed in the visible, infrared, and x-ray regions of the electromagnetic spectrum. Experiments in the visible region include experiments using research quality high-resolution Czerny-Turner scanning spectrometers, in which the normal and anomalous Zeeman effect is investigated, and in which the

mass of the deuteron is measured. X-ray experiments include x-ray diffractometry to investigate crystal structure and an experiment using proton-induced x-ray emission (PIXE) to investigate Mosley's Law. The PIXE experiment is performed in the Naval Academy Tandem Accelerator Laboratory. Fourier-Transform Infrared (FTIR) spectrometry is used to investigate molecular energy levels in gases.

## Enhancement of Hydrodynamic Flow Radiation by the Regulation of Air Bubbles in a Turbulent Water Jet

Researcher: Associate Professor Murray S. Korman

Experimental results show that the near-field hydrodynamic radiated flow noise (generated by a turbulent submerged circular water jet) is enhanced when the turbulent flow is modified to become a two-phase flow containing air bubbles. Acoustic intensity spectra, in the frequency band between 20 and 7000 Hz, are measured using a digital spectrum analyzer from signals generated by a hydrophone placed at the position of  $Z = 4d$  and  $R = 4d$ . Here,  $Z$  and  $R$  are the axial and radial positions from the nozzle exit, respectively. The water velocity is 12

m/s at the nozzle exit (of diameter  $d = 0.635$  cm). An amplification factor defined by the ratio of intensities  $I_{\text{two-phase flow}}/I_{\text{fluid flow}}$  is measured as a function of the void fraction  $\alpha$  of the air bubbles in an effort to verify the theoretical amplification predictions made by Crighton and Williams [*Journal of Fluid Mechanics* 36, (1969), 585-603] and more recently by Prosperetti [*J. Acoust. Soc. Am.* 84, (1988), 1042-1054]. This research was funded by The National Center for Physical Acoustics at the University of Mississippi.

## Research Course Projects

### PIXE Elemental Analysis of Oyster Shells

Researcher: Midshipmen 1/C Amy G. Delavan and  
Julie L. Wolfgram, USN

Advisers: Professor Francis D. Correll,  
Associate Professor James R. Huddle, and  
Professor Douglas W. Edsall (Oceanography)

Oyster shells were collected from several different areas in and around the Chesapeake Bay, from Chincoteague Bay (Virginia), and from East Bay (Pensacola, Florida) for elemental analysis using particle-induced x-ray emission (PIXE). High concentrations of Ca, Mn, Fe, and Zn, and traces of

Ba and Pb, were found in all of the samples. Other elements detected in some shells included Ti, Ni, Cu, As, Br, and Sr. Several shells were sectioned and their compositions measured at different depths to gain information about possible changes in their environment over time.

### Proton-Induced X-ray Emission (PIXE) Studies of Calcites

Researcher: Midshipman 1/C Christoph J. Flaherty, USN

Advisers: Professor Francis D. Correll and  
Associate Professor James R. Huddle

The electronic properties of three different types of calcites (Iceland Spar, Swakopmund, and Gallatin) are markedly different, as is made evident by differences in their dielectric relaxation spectra. PIXE analyses of samples of the three types of calcite were used to determine concentrations of

trace elements in order to provide data for other investigators attempting to explain the different dielectric spectra. The Iceland Spar showed relatively low levels of trace elements, whereas the Swakopmund calcite had high levels of Sr, and the Gallatin calcite had high concentrations of Ga.



### Low Temperature Electrical Properties of Calcite

Researcher: Midshipman 1/C Jon R. Galloway, USN

Adviser: Professor John J. Fontanella

Audio frequency dielectric constant and loss have been measured over the temperature range 5.5-300K for calcite obtained from several geographical regions. Several new relaxations were observed, including one at very low temperatures.

The spectrum is found to be characteristic of the origin of the calcite. The activation parameters for each were determined, and an attempt was made to identify the origin of each relaxation.

### Experimental Investigation on the Amplification of Hydrodynamic Noise Generation by the Insertion of Bubbles in a Turbulent Flow

Researcher: Midshipman 1/C Charlene E. Hughes, USN

Adviser: Associate Professor Murray S. Korman

An apparatus is constructed to produce a turbulent shear flow that is generated by a submerged circular jet. The jet is arranged to flow in an upright position. Comparisons are made of the near-field hydrodynamic flow noise when the jet flow becomes a composition of two-phase flow that consists of air bubbles in water. The near-field flow noise is measured by a hydrophone located at the point, four nozzle diameters from the exit, and four nozzle diameters perpendicular to the jet axis. Preliminary results indicate that the acoustic spectra are greatly amplified in the case where the bubbles are introduced into the flow. Measurements of the

acoustic intensity are made as a function of void fraction  $\beta$  (the ratio of air volume to total volume) in an effort to verify the theoretical amplification predictions made by Crighton and Williams [*Journal of Fluid Mechanics*, 36 (1969), 585-603] and more recently by Prosperetti [*Journal of the Acoustical Society of America*, 84 (1988), 1042-1054]. Tests were performed in the U.S. Naval Academy Hydrodynamics Tow Tank. (This research is a continuation of the work on ocean noise mechanisms that is supported by the National Center for Physical Acoustics at the University of Mississippi and the Office of Naval Research.)

### Holographic Interferometry on an Acoustic Guitar

Researcher: Midshipman 1/C Michael D. Matson, USN

Adviser: Assistant Professor Steven R. Montgomery

Time-averaged holographic interferometry has received much attention as a means of vibration analysis. The scheme for producing the interferogram is the same as that for producing a conventional hologram, except that the object is allowed to vibrate. What is stored in the developed film plate can then be imagined as a set of holograms whose reconstructions interfere to produce a single virtual image with interference fringes that map the vibration pattern of the original object. For this study the vibrations on the faceplate of a steel string acoustic guitar were

analyzed. Previous interferometric studies on the guitar have utilized a mechanical oscillator in direct contact with the faceplate to set up standing waves. The researcher chose to excite the faceplate by establishing standing waves on a string using an alternating electric current in one of the steel strings with a large permanent magnet nearby to produce a periodic force on the string. The resulting interferograms with this form of excitation show how string vibrations couple to the faceplate vibrational modes.

## **Turbulent Energy Spectrum Predictions by Nonlinear Acoustic Scattering**

Researcher: Midshipman 1/C James E. Parker III, USN  
Adviser: Associate Professor Murray S. Korman

An underwater nonlinear experiment is performed involving the propagation of finite-amplitude sound waves through a turbulent flow. The experimental geometry involves the interaction of two mutually perpendicular crossed ultrasonic beams that are generated by individual focused transducer units (with frequencies of 2.0 and 2.1 MHz, respectively). The alignment positions the center of the interaction at the overlapping focal regions. A mechanical apparatus allows the crossed beams to rotate in a horizontal plane containing the submerged circular water jet. The beam axes always remain perpendicular. In the presence of turbulence, a radiated nonlinear sum frequency component ( $f+ = 4.1$  MHz) is scattered and

detected by a receiving transducer unit located outside the interaction region. In the absence of turbulence, there is virtually no nonlinear scattering. Measurements of the broadened intensity spectrum versus angle contain statistical information about the turbulent velocity components. Further analysis shows that focused crossed beam scattering exhibits good spatial resolution. From theory [Korman and Beyer, *J. Acoust. Soc. Am.* **85**, (1989), 611-620] the energy spectrum of turbulence  $E(k,r)$  (where  $k$  is the wave number of the turbulent eddies) is predicted by performing angular measurements at several scan positions  $r$  across the jet. (Work supported by the Naval Academy Research Council.)

## **Exploration of Turbulence by Nonlinear Acoustic Scattering**

Researcher: Midshipman 1/C James E. Parker III, USN  
Adviser: Associate Professor Murray S. Korman

A system has been developed to explore the nuances of nonlinear scattering in the presence of turbulence. The computer-controlled scattering apparatus makes translational and rotational "crossed beam" measurements of the nonlinear interaction. This is made possible by the geometry of the transducer setup, resolution of the focused transducers, and mobility of the transducer mounting unit. Two ultrasonic focused transducers (of sinusoidal driving frequencies 2.0 and 2.1 MHz) are mounted mutually perpendicular and with their focal points overlapping. The enhanced spatial resolution results from the minimal interaction volume defined by the intersection of the focused sound beams. The transducer mount is allowed to

pivot about the vertical axis while independently translating across a submerged water jet. The 1/4-in. circular jet is the source of turbulence in this system. By making several cat scans of the turbulent jet at all angles, one is able to map out several statistical properties of the randomly fluctuating turbulent velocity components. In particular, one can experimentally determine the energy spectrum of turbulence  $E(k,r)$  (where  $k$  is the wave number of the turbulent eddies and  $r$  the radial position in the jet) [See also M. S. Korman and R. T. Beyer, *Journal of the Acoustical Society of America* **85**, (1989), 611-620.] (This work was supported by Naval Academy Research Council.)

## **Experimental Investigation of the Nearfield Radiated Noise Spectrum from a Submerged Water Jet**

Researcher: Midshipman 3/C Morgen Paul, USN  
Adviser: Associate Professor Murray S. Korman

Acoustic experiments are performed in the 20ft x 20 ft x 16 ft deep section of the U.S. Naval Academy Tow Tank facility to measure the behavior of the near-field radiated noise spectrum of a turbulent submerged water jet. The nozzle diam of the jet is  $d = 1/4$  inch. A hydrophone (located at the

coordinate position of  $4d$  from the jet axis and  $4d$  perpendicular to the axis) detects the local pressure fluctuations produced by the turbulent eddies in the shear flow. A Lecroy 7200 Digital Oscilloscope detects the amplified and filtered electronic signals from the hydrophone output. The average of 20

FFT power spectral density curves demonstrates that the flow noise spectrum is in a band covering a few Hz to  $\approx 500$  Hz. The total power in the band is measured as a function of the nozzle exit velocity  $U_0$  from a range of 3m/s to 13m/s. Results show that the near-field acoustic intensity is proportional to  $U_0^{3.6}$  where the exponent 3.6 may be in error by about 10 percent. Results by D. W. Jorgensen [*J. Acoust. Soc. Am.*, 33 (1961), 817] suggest that the normalized rms pressure spectrum,  $p/0.5 \rho U_0^2$ , as a function of Strouhal number  $f d/U_0$  takes on a

spectral shape that is independent of Mach number  $U_0/c$  (where  $c$  is the speed of sound). Therefore one should expect the power law to be exactly 4 in this case. The results reported here may perhaps improve if one took into consideration the normal mode resonances caused by the boundaries of the tank. These near-field measurements are important; first, for verification purposes and second for comparison to the "enhanced" near-field radiated noise when bubbles are added to the turbulent jet flow.

## Elemental Analysis of Mid-Ocean Ridge Metalliferous Sulfide Deposits By PIXE

Researcher: Midshipman 1/C James R. Pietila, USN  
Advisers: Professor Francis D. Correll,  
Associate Professor James R. Huddle, and  
Professor Douglas W. Edsall (Oceanography)

An elemental analysis of hydrothermal vent deposits was performed using 3-MeV proton-induced x-ray emission (PIXE). Concentrations of Au, Ag, Ni, Cu, Fe, Zn, and Mn in these deposits were determined for the first time using PIXE. The 13 samples studied came from sulfide-rich vent sites located at: (1) Mid-Atlantic Ridge, TAG site (26°45'N, 44°49'W, 3700 m); (2) Guaymas Basin

(27°00'N, 11°24'W, 2000 m; and 27°36'N 111°29'W, 2000 m); (3) Eastern Pacific Rise (20°49'N, 109°06'W, 2000-2200 m); and (4) Eastern Pacific Rise (09°49'N, 104°18'W, 2502 m). The apparent concentrations of Fe, Cu, and Zn were high in all samples, while Ag was identified in only three. Work is continuing to convert the raw data into reliable concentration values.

## Xenon-127 Spectroscopy for Solar Neutrino Detection

Researcher: Midshipman 1/C Gerhard S. Schoenthal, USN  
Adviser: Assistant Professor Jeffrey R. Vanhoy,

The implementation of  $^{127}\text{I}$  as a neutrino detector is a topic of considerable interest in solar astrophysics. To date, no experiments have been able to measure directly the Gamov-Teller matrix elements for scattering to the final states of interest in  $^{127}\text{Xe}$  (spins 3/2, 5/2, 7/2). The limitation is that the detector systems in the intermediate energy experiments cannot cleanly resolve states separated by  $\approx 50$  keV. Thus it appears that the neutrino capture cross-sections will have to be estimated from theoretical calculations guided by spectroscopic measurements in  $^{127}\text{I}$  and  $^{127}\text{Xe}$ .

Two experimental runs during the previous year were dedicated to studying Xenon with the  $^{127}\text{I}(p,ng)$  reaction. Measurements of (p,ng) angular distributions and  $\gamma$ - $\gamma$  correlations were made at  $E_p = 6.2$  MeV. Data have been analyzed

to the point of extracting relative (p,n) cross sections and branching ratios. The researcher has yet to complete analysis of the singles angular distributions and coincidence data.

Final states in  $^{127}\text{Xe}$  are formed non-selectively, since the (p,n $\gamma$ ) reaction proceeds through the compound nucleus mechanism. The maximum observable spin ( $J = 11/2$ ) is controlled by the proton penetrability. A proton beam energy of  $E_p = 6.2$  MeV populates final states up to 1.3 MeV.

The (p,n) cross sections to each level can be inferred from gamma ray data. For comparison, cross-sections were calculated using the code CINDY with Johnson and Smith optical model parameters. From the data, one may conclude that the 411 keV level definitely is spin  $J = 1/2$  and that the 321 keV level is  $J \neq 1/2$ . These results are

consistent with those of Garcia, but in contrast to those of Lonnroth. Both Lonnroth and Helppi list a state at 419 keV which decays into the 342 keV  $J = 7/2^+$  state via a 77 keV  $\gamma$ -ray. This transition is not observed at any reasonable strength in the present data and suggests that if the state exists, its

spin must be  $\geq 11/2$ .

This research had the following as collaborators: Sally F Hicks and C.L. Lundstedt from the University of Dallas and D. Wang and M.T. McEllistream from the University of Kentucky.

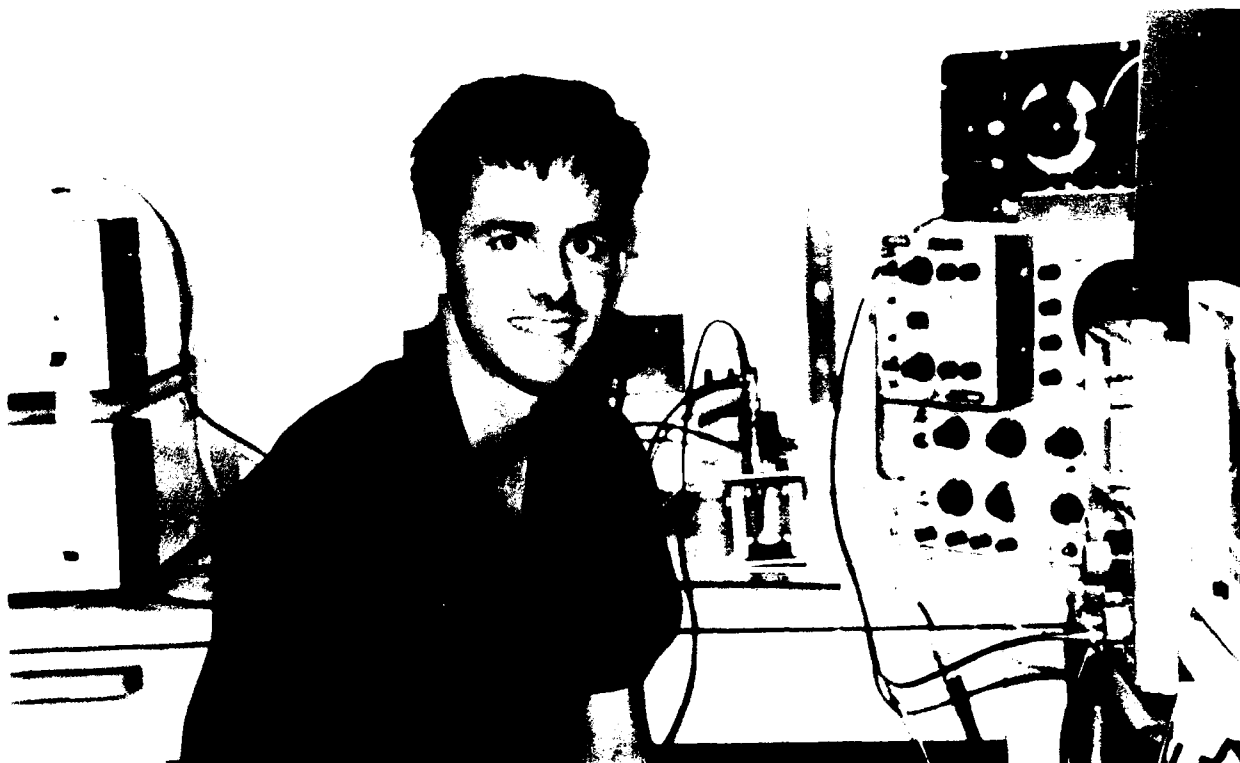
## Measurement of the Rydberg Energy by Proton-Induced X-ray Emission

Researcher: Midshipman 1/C Christopher W. Slawson, USN

Adviser: Associate Professor James R. Huddle

Two MeV protons extracted from the Naval Academy Tandem Accelerator were directed through a Kapton vacuum interface onto a variety of thick elemental targets with atomic number  $13 < Z < 50$  in a chamber specially designed for ex-vacuo Proton-Induced X-ray Emission studies. Characteristic x-ray spectra from each target were collected with a Si(Li) detector and analyzed with a multichannel analyzer. The energies of the characteristic x-rays measured in this way were analyzed using Moseley's Law, which is derivable from Bohr's Atomic Theory, and which predicts that characteristic x-ray energies will be proportional to  $(Z-1)^2$ . The value of the Rydberg energy,  $R_{ch}$ , determined from the slope of the  $K\alpha$  x-ray energies

plotted as a function of  $(Z-1)^2$  is  $14.000 \pm 0.031$  eV, which does not agree with the accurately known value of  $13.605\,698\,1(40)$  eV to within the experimental uncertainty, even though the two values differ by less than 3%. In an attempt to improve the accuracy and reduce the uncertainty of the experimentally determined value of the Rydberg energy, the data were analyzed again using the quantum-mechanically correct expression for the atomic energy levels including fine structure and electronic screening effects. The new analysis yields a value for the Rydberg energy that differs from the value quoted by Cohen and Taylor by 8%, indicating that the screening factors given by Pauling and Goudsmit are in error.



## Publications

ANTHONY, John M., Assistant Professor, co-author, "K-Shell Ionization of O<sup>4+</sup> and C<sup>2+</sup> Ions In Fast Collisions with H<sub>2</sub> and He Gas Targets", *Physical Review A*, 46, 3 (1 August 1992), 1374-1387.

Cross sections for 1s ionization of the 1s<sup>2</sup>2s<sup>2</sup> and 1s<sup>2</sup>2s2p <sup>3</sup>P (metastable) states of C<sup>2+</sup> and 4+ ions in 0.5 - 1.8 MeV/u collisions with H<sub>2</sub> and He targets were measured using 0<sub>1</sub> projectile Auger electron spectroscopy. Calculations of the K-shell ionization cross-section, ( $\sigma_K$ ), were performed, including contributions from projectile electron-target nucleus interactions, ( $\sigma_{enl}$ ), within a Plane-Wave Born Approximation (PWBA), and contributions from projectile electron-target electron interactions ( $\sigma_{eel}$ ), within an Impulse Approximation (IA). The theoretical total cross-section  $\sigma_K = \sigma_{enl} + \sigma_{eel}$  was found to be in overall agreement with the K-shell ionization measurements, indicating a contribution of up to ~30% due to the electron-electron interactions. Separate screening-antiscreening calculations of  $\sigma_K$  were also performed and found to be in overall agreement with the data. These results suggest that the IA calculation of  $\sigma_{eel}$ , when combined with a PWBA calculation of  $\sigma_{enl}$ , is quite adequate for describing K-shell ionization.

BRILL, Donald W., Professor, "Backscattering of Sound Pulses by Elastic Bodies Underwater," *Applied Acoustics*, 33, 2 (May 1991), 87-107.

This paper studies the scattering interaction of an incident acoustic pulse and an elastic target. The pulse emerges from a distant transducer and can have any arbitrary shape and finite duration. The target is an elastic body, here assumed to be spherical and homogeneous. The Fourier integral representation of the incident pulse is combined with the resonance-scattering representation of the scattered pressure field to yield a filter-type integral that can be viewed as filtering the form function of the scatterer through the spectral window of the incident transient pulse (ping). The researcher analyzes the backscattered pulses when the incident pulses are of three simple types. The analysis is carried out in the frequency and time domains, and results are illustrated with numerical predictions for a variety of instances of increasing complexity and interest. The nature of the backscattered echo is explained in two instances for either short or long pulses. These instances correspond to cases in which the incident pulse has a carrier frequency that either coincides with any of the natural resonances

of the submerged sphere or not. The main advantage of short pulses is that they can be used to replicate the (steady state) sonar cross-section of scatterers. Ultimately, if the incident pulse were a delta function in  $\tau$ , the spectrum of the backscattered pulse would be exactly the form function  $f_{\infty}(\pi, x)$  divided by  $r$ . The backscattering sonar cross section (BSCS) would then be represented by  $|f_{\infty}(\pi, x)|^2$ . For a narrow incident continuous wave (c.w.) pulse in  $\tau$  (but not infinitely narrow as is the delta function), having a carrier frequency  $x_0$ , the replication of the BSCS would be accurate up to about that value of  $x_0$ . Long pulses excite single target resonances and produce echoes that are quite similar to those produced by c.w. incidences. This analysis can be analogously carried out for arbitrary pulses incident on targets of more general shapes and lossy (i.e., viscoelastic) composition.

ELDER, Samuel E., Professor, "The Mechanism of Sound Production in Organ Pipes and Cavity Resonators," *Journal of the Acoustical Society of Japan*, 47, 11 (1991), 883-892 (in Japanese) and *Journal of the Acoustical Society of Japan*, (E), 13, 1 (1992), 11-24 (in English).

A new unified method of treating the sounding mechanism of organ pipes and cavity resonators replaces the *control-volume* method, which until recently has been the most widely accepted theory. It is shown that shear layers contain a *dividing surface* whose motions control the production of sound in the resonant cavity. Both jet-drive and force drive contributions are found to be involved in the sounding mechanism. The present approach shows the drive system to be inherently linear over a range of shear layer widths, so that sinusoidal oscillation is readily achievable. For voicing situations calling for spectra rich in harmonics, nonlinear drive is attained by resorting to a smaller ratio of jet width to lip cutup which, at high enough Reynolds number, permits the growth eddies which result in impulsive action at the lip.

ENGLE, Irene M., Associate Professor, "The Field of the Jovian Magnetosphere, Including Contributions of the Magnetopause Surface Currents," *Advances in Space Research*, 12, 8 (1992), 249-255.

An idealized large-scale Jovian magnetospheric field has been computed by calculating the contribution due to the currents on the surface of the

magnetopause (calculated from theory). This contribution is added to those of a model current system in the magnetic equatorial plane and the intrinsic dipole field of the planet. Convenient spherical harmonic representations of the field in the region inside the magnetopause have been developed. The Voyager observation model is compared with the Pioneer observation model. The abstract is that associated with a solicited manuscript published in *Advances in Space Research* in spring 1992. The manuscript was delivered to the publisher late in the summer of 1990 and was based upon presentations delivered at Cal Tech early in June 1990 and a shorter version which was presented at the Hague, the Netherlands, on 27 June 1990, at the 1990 plenary meeting of COSPAR (Congress on Space Research).

FONTANELLA, John J., Professor, and Mary C. WINTERSGILL, Associate Professor, "The Low Temperature Dielectric Behavior of Polymers and Copolymers of Tetrafluoroethylene," *Macromolecules*, **24** (1991), 3853-3856.

Dielectric measurements were made on a series of polymers containing tetrafluoroethylene at temperatures from 10 to 300K and frequencies from 10 to  $10^5$  Hz. In all cases, the local mode  $\alpha$ -relaxation was observed. In FEP and PFA which contain  $DF_3$  and  $n-C_3F_7O$  branches, respectively, there is also a lower temperature relaxation for which the activation entropy is close to zero. In Teflon AF, an amorphous copolymer containing a large number of dioxole rings, three relaxations were observed, including the glass transition near 200°C.

FONTANELLA, John J., Professor, and Mary C. WINTERSGILL, Associate Professor, "Internal Motions in a Copolymer of Ethylene with 56 Mole% Vinyl Alcohol," *Plastics, Rubber, and Composites: Processing and Applications*, **16** (1991), 255-259.

The copolymer of ethylene with 56 mole% vinyl alcohol has a well-defined melting point at 165°C by DSC but limited crystalline order by x-ray diffraction. Dielectric properties were measured at temperatures from 6K to the melting point. Two relaxations were observed. The low temperature relaxation at 198 to 275K has an activation energy of 12-13 kcal/mole. The high temperature  $\alpha$ -relaxation is partially obscured by the effects of conductivity. In a dry sample, it appears as a peak in the electric loss modulus,  $M''$ , at 124°C and  $10^3$  Hz and in the dynamical mechanical loss modulus,

$E''$ , at 58°C and 1 Hz. Its activation energy is 25 kcal/mole. After conditioning to 97% R.H., the temperature of the  $M''$  peak at  $10^3$  Hz is reduced by 80°C.

FONTANELLA, John J., Professor, and Mary C. WINTERSGILL, Associate Professor, "Effect of Absorbed Chemicals on the Low-Temperature Dielectric Properties of Poly(tetrafluoroethylene)," *Macromolecules*, **25** (1992), 1475-1479.

Dielectric measurements were made from 5 to 300 K on poly(tetrafluoroethylene) which had been saturated with chloroform, fluorocarbon-113 (1,2,2-trichloro-1,2,2-trifluoroethane), or carbon tetrachloride. The peak height for the  $\gamma$  relaxation was increased by the polar additives. In the case of fluorocarbon-113 at frequencies below 1 kHz, it was shifted to lower temperatures with a lower activation energy. In the presence of either of the polar additives, a new relaxation appeared with a maximum  $\tan \delta$  at 1 kHz of 49K for chloroform and 61K for fluorocarbon-113 in isothermal frequency scans. These relaxations had activation energies of 2-3 kcal/mol and activation entropies close to zero. They are assigned to the reorientation of the absorbed molecules moving independently of each other. In separate measurements on chloroform and fluorocarbon-113, a relaxation was observed at temperatures below their melting points which became weaker after purification.

FONTANELLA, John J., Professor, John J. WILSON, Ensign, USN, Michael K. SMITH, Lieutenant Commander, USN, Mary C. WINTERSGILL, Associate Professor, and Christopher S. COUGHLIN, Office of Naval Technology Postdoctoral Fellow, co-authors "Electrical Relaxation in Poly(propylene oxide) with and without Alkali Metal Salts," *Solid State Ionics*, **50** (1992), 259-271.

Previously-published audio frequency complex impedance studies of poly(propylene oxide) PPO containing various ions at pressures up to 0.6 GPa over the temperature range 250-350K have been re-analyzed in terms of electric modulus. Peaks in the electric modulus plots (conductivity relaxation) are found which are characterized in terms of the stretched exponential. It is shown that those fits are not perfect, in part due to the presence of a low temperature relaxation. As a consequence, different values of the stretched exponential parameter,  $\beta_{SE}$ , are obtained when different portions of the curve are analyzed. That effect results in an apparent

increase in  $\beta_{SE}$  with increasing temperature or decreasing pressure. However, when the same portion of the peak is fit,  $\beta_{SE}$  is found to be approximately 0.5 and independent of temperature and pressure.

Next, data for the  $\alpha$ -relaxation in pure PPO were reanalyzed. It is shown that while the value of  $\beta_{SE}$  for the  $\alpha$ -relaxation data is similar to the values determined for the conductivity relaxation,  $\beta_{SE}$  for the electric modulus representation of the  $\alpha$ -relaxation data is somewhat smaller. In addition, the temperature dependence of the average relaxation time for the electric modulus representation is better fit by the BENSCH equation than by the Vogel equation, while the opposite is true for the dielectric constant data.

FONTANELLA, John J., Professor, Mary C. WINTERSGILL, Associate Professor, "The Low Temperature Dielectric Behavior of Polymers and Copolymers of Tetrafluoroethylene," *Proceedings of the Twentieth North American Thermal Analysis Conference*, (1992), 103-108.

Dielectric measurements were made on a series of polymers containing tetrafluoroethylene at temperatures from 10 to 300K and frequencies from 10 to  $10^5$  Hz. In all cases, the local mode  $\alpha$ -relaxation was observed. In FEP and PFA which contain  $CF_3$  and  $n-C_3F_7O$  branches, respectively, there is also a lower temperature relaxation for which the activation entropy is close to zero. In Teflon AF, an amorphous copolymer containing a large number of dioxole rings, four relaxations were observed, including the glass transition near 200°C.

MacLAREN, Steven A., Ensign, USN, Francis D. CORRELL, Professor, James R. HUDDLE, Associate Professor, Jeffrey R. VANHOY, Associate Professor, and William D. KULP, Ensign, USN, "A Simple External-Beam Ion Microprobe System for in-Air PIXE," *Nuclear Instruments and Methods in Physics Research*, **B56/57** (1991), 708.

A simple external-beam milliprobe system was designed and constructed as part of an undergraduate honors research project. The system includes an adjustable object slit, a compact electrostatic quadrupole triplet lens, a lens positioner, and a shielded tip with a thin Kapton window through which the beam exits the accelerator vacuum and enters a sample enclosure with interlocked doors. Auxiliary equipment includes a four segment lens-entrance collimator with a beam-current monitor that facilitates steering the beam and an interlock system that intercepts the beam when any of the doors to the sample enclosure are opened. Details of the design and construction of the system were presented and its performance described.

TANKERSLEY, Lawrence L., Professor, co-author, "Second Stokes Generation in Deuterium and Hydrogen," *Optics Communications*, **86** (1991), 538.

The researchers have investigated the transient generation of second Stokes radiation in deuterium and hydrogen as a function of gas pressure and pump energy. They have measured the threshold energies for the first and second Stokes as a function of pressure and have found different behaviors for the second Stokes threshold in the high and low pressure regimes. The researchers postulate that the different threshold behaviors are caused by the relative importance of four-wave mixing to the total second Stokes signal in the two regimes. Further data, based on the pulse energy statistics of the first and second Stokes, are presented that supports the postulate that the second Stokes seeding is dominated by four-wave mixing at low pressures and by amplified quantum noise at high gas pressures. Measurements of the spatial profiles of the second Stokes were also made and are consistent with this interpretation.

TANKERSLEY, Lawrence L., Professor, co-author, "Time Gated Imaging through Scattering Media Using Stimulated Raman Amplification," *Optics Letters*, **16**, 23 (1991), 1868.

The researchers propose the use of stimulated Raman scattering for time-gated image amplification and demonstrate its use for the detection of images through strongly scattering materials. Using 30 ps pulses from a frequency-doubled Nd:YAG laser, the researchers have amplified and detected images through suspensions of latex spheres and non-dairy creamer with spatial resolution less than 300  $\mu m$  and at concentrations such that the non-scattered extinction ratios were as large as c-40. The time-gated image amplifier can produce images under conditions in which the scattering medium is sufficiently dense that an image cannot be seen using multiple exposures on a streak camera or time integrated exposures on a sensitive, low-noise CCD camera.

TANKERSLEY, Lawrence L., Professor, co-author, "Quantum Limited Imaging in a Stimulated Raman Amplifier and Applications in Time-gated Imaging through Scattering Media," reprinted in *Nonlinear Optics III*, **1626** (1991), 325-336.

The researchers review the noise characteristics and the low-light-level imaging capabilities of a stimulated Raman amplifier and show how these properties can be combined with time-gating capabilities to image through dense scattering materials. Using 30 psec time-gating pulses, images were obtained of a resolution bar chart viewed through either a suspension of 0.364 mm poly-

styrene spheres where the forward attenuation due to scattering was e28, or through a non-dairy creamer solution where the attenuation was up to e33. At the highest scattering attenuation levels these images could not be detected by any conventional imaging method.

TREACY, Donald R., Professor, co-author, "Electron-Nuclear Double Resonance of the Phosphorous Antisite in InP Detected via Photoluminescence," *Bulletin of the American Physics Society*, 37 (1992), 252.

Optically detected electron-nuclear double resonance (ODENDOR) has been observed via photoluminescence from the first neighbor  $^{31}\text{P}$  shell of the phosphorous antisite in zinc doped InP. Analysis of the ENDOR data confirms a tetrahedral arrangement of  $^{31}\text{P}$  nuclei. The hyperfine interaction for each of these nuclei is axial with  $|A| = 368.0 \pm 0.5$  MHz and  $|A| = 247.8 \pm 0.5$  MHz. These parameters are similar to those reported by Jeon. A shift of the ENDOR frequencies correlated with a change in the central nuclear spin state has also been observed. The researchers have been able to account for this shift with a perturbation treatment in which the electronic spin and the central nuclear spin are treated exactly and a neighboring nuclear spin provides the perturbation. The best ENDOR signals are obtained with low optical excitation power density ( $0.1 \text{ W/cm}^2$ ) and low microwave modulation frequency (17 Hz). These conditions emphasize the contributions to the optically detected magnetic resonance (ODMR) signal from distant donor-acceptor pairs. The temporal response of the ODMR and ODENDOR signals are currently being investigated in an effort to understand the origin of the ODENDOR signal.

VANHOY, Jeffrey R., Assistant Professor, Francis D. CORRELL, Professor, James R. HUDDLE, Associate Professor, William D. KULP and Steven A. MacLAREN, Ensigns, USN. "NATALY Naval Academy Tandem Accelerator Laboratory SNEAP 1990 Report," *Proceedings of the Symposium of Northeastern Accelerator Personnel - 1990*, Eds. T. Tipping and R. Krause. Singapore: World Scientific, 1991, p. 346.

This conference paper describes developments to the accelerator laboratory during 1990. Included are discussions on the radiation monitoring system, a small-aperture electrostatic quadrupole triplet, operating instructions and procedures, and experience with the LabVIEW (National Instruments) control package.

VANHOY, Jeffrey R., Assistant Professor, co-author, "Search for Various Collective Excitation Modes with the  $(n,n'\gamma)$  Reaction," *Proceedings of*

the Third International Spring Seminar on Nuclear Physics: Understanding the Variety of Nuclear Excitations, ed. A. Covello, Singapore: World Scientific, 1991, p. 191.

It is demonstrated that a combination of the  $(n,n'\gamma)$  reaction and the Doppler-shift attenuation method is an extremely useful tool to identify various kinds of low energy collective excitations. Evidence for double octupole and quadrupole-octupole modes are presented in  $^{96}\text{Zr}$  and  $^{144}\text{Sm}$  nuclei. Newly measured transition rates of the  $2^+$  mixed-symmetry states in the  $^{134}\text{Ba}$  O(6) nucleus are reported.

VANHOY, Jeffrey R., Assistant Professor, co-author, "Neutron-Proton Dynamics of  $^{48}\text{Ca}$  Levels and  $\gamma$ -Ray Decays from Inelastic Neutron Scattering," *Physical Review* 45, (1992), 1628.

Differential cross-sections were measured for the  $^{48}\text{Ca}(n,n'\gamma)$  reactions at incident energies between 4.8 and 8.0 MeV. Excitation energies, spins, level lifetimes,  $\gamma$ -ray branching ratios, and  $\gamma$ -ray production cross-sections were determined. Members of the doublet at 4.50 MeV are clearly identified and assigned spins of  $4^+$  and  $3^-$ . Inelastic neutron scattering cross-sections were inferred from the  $\gamma$ -ray branching ratios and production cross-sections. The inferred cross-sections are in excellent agreement with those measured in a separate neutron detection experiment, and with a recent vibrational model coupled-channels analysis of the  $^{48}\text{Ca}(n,n')$  data. Comparison of level excitations produced by neutrons and other hadrons with electromagnetic strengths shows very different mixtures of neutron and proton particle-hole amplitudes for different levels.

WINTERSGILL, Mary C., Associate Professor, John J. FONTANELLA, Professor, and Christopher S. COUGHLIN, Office of Naval Technology Postdoctoral Fellow "Complex Impedance and Multifrequency  $^{23}\text{Na}$  NMR Study of Poly(Propylene oxide) Complexed with  $\text{NaB}(\text{C}_6\text{H}_5)_4$ ," *Solid State Ionics*, 45 (1991), 277-284.

Complex impedance and multifrequency  $^{23}\text{Na}$  nuclear magnetic resonance (NMR) measurements on a poly(propylene oxide):sodium tetraphenylborate,  $(\text{PPO})_8\text{NaB}(\text{C}_6\text{H}_5)_4$ , solid polymer electrolyte, with a composition of eight ether oxygens per sodium, are reported. The NMR linewidths are found to be second-order quadrupole broadened, thus indicating low site-symmetry for the  $\text{Na}^+$  ions. The title compound exhibits some interesting differences in properties compared to other PPO - Na salt complexes, including an anomalously low value of the stretched exponential parameter  $\beta_{sc}$  (obtained in fits to electric modulus data), an unusually high glass transition temperature



( $T_g = 306\text{K}$ ), and sub- $T_g$  line narrowing of lower frequency  $^{23}\text{Na}$  resonances. This last phenomenon is attributed to strong interaction between the  $\text{Na}^+$  ions and their large  $[\text{B}(\text{C}_6\text{H}_5)_4]^-$  counterions caused by the localization of the  $[\text{B}(\text{C}_6\text{H}_5)_4]^-$  anions in weak interactions with the polymer chains which, in turn, leads to the elevated glass transition temperatures.

WINTERSGILL, Mary C., Associate Professor, Joseph F. LOMAX, Assistant Professor, (Chemistry), and John J. FONTANELLA, Professor, "Disorder in  $\beta$ " Aluminas: Dielectric Relaxation and X-ray Absorption", *Physical Review B*, 45 (1992), 6369-6375.

$\beta$ "-aluminas substituted with rare earths (Pr, Nd, Er and Tb) and Sn have been studied using dielectric relaxation and near-edge and extended x-ray absorption fine structure (NEXAFS and EXAFS). In addition, dielectric relaxation (DR) measurements have been made on Na- $\beta$ , Na- $\beta$ " and Na-Er- $\beta$ " alumina. Both the DR and EXAFS results confirm that disorder, particularly in the conduction plane, in the vicinity of the rare earth ions is a key feature of the  $\beta$ "-aluminas. The NEXAFS studies show that the rare earth ions are ionized to trivalency and are highly localized; in contrast, Sn is clearly divalent, as in  $\text{SnO}$ .



## Presentations

ANTHONY, John M., Assistant Professor, co-author, "K-Shell Ionization of O4+ and C2+ Ions In Fast Collisions with H2 and He Gas Targets," Division of Atom Molecular and Optical Physics Meeting of the American Physical Society, Chicago, Illinois, 20-22 May 1992.

BRILL, Donald W., Professor, "Analytical Simulation Studies of the Acoustic Diffraction Resulting from the Insonification of Submerged, Ribbed, Cylindrical Structures," Ultrasonics International '91 Conference, Le Touquet, France, 1-4 July 1991.

CORRELL, Francis D., Professor, co-author, "Teaching Undergraduate Physics With a Small Tandem Accelerator: Moseley's Law," American Association of Physics Teachers Summer Meeting, Vancouver, British Columbia, Canada, 24-29 June 1991.

CORRELL, Francis D., Professor, co-author, "Characterization of Ti Alloys Bombarded by keV Deuterium Ions," Materials Research Society Spring Meeting, San Francisco, California, 27 April-1 May 1992.

ELDER, Samuel E., Professor, "A Model of Jet-Resonator Action Based on the Air Reed, or Vibrating Diaphragm Concept," special session on Organ Acoustics, 123rd Meeting of the Acoustical Society of America, Salt Lake City, Utah, 14 May 1992.

ENGLE, Irene E., Associate Professor, "Diurnal Precession of the Jovian Magnetosphere," 1992 Spring Meeting of the American Geophysical Union, Montreal, Quebec, Canada, 29 May 1992.

ENGLE, Irene E., Associate Professor, "Diurnal Variation in Jovian Subsolar Magnetopause Position," 1992 Spring Meeting of the American Geophysical Union, Montreal, Canada, 29 May 1992.

ENGLE, Irene E., Associate Professor, "Magnetospheres of the Outer Planets," International Symposium, University of California at Los Angeles, Los Angeles, California, 24 June 1992.

ENGLE, Irene E., Associate Professor, "Women Physicists: The Changing Milieu, Then and Now" Symposium of the American Physical Society Meeting, Indianapolis, Indiana, 18 March 1992.

ENGLE, Irene E., Associate Professor, "Women in Physics and Engineering: The Changing Milieu, Then and Now," Women in Science and Engineering Convention, Roslyn, Virginia, 25 March 1992.

ENGLE, Irene E., Associate Professor, "Women in Physics: Contemporary Vignettes through the Years," Special Seminar, Pennsylvania State University, State College, Pennsylvania, 26 March 1992.

HUDDLE, James R., Associate Professor, "Tips on Viewing and Photographing the Lunar Eclipse of 14-15 June 1992," John Downs Park, Pasadena, Maryland, 10 May 1992.

HUDDLE, James R., Associate Professor, "Images of the Great Total Solar Eclipse of 1991," John Downs Park, Pasadena, Maryland, 19 March 1992.

HUDDLE, James R., Associate Professor, "Images of the Great Total Solar Eclipse of 1991," U.S. Naval Academy Astronomy Club and U.S. Naval Academy Society of Physics Students Joint Meeting, Annapolis, Maryland, 2 December 1991.

HUDDLE, James R., Associate Professor, Francis D. CORRELL, Professor, Jeffrey R. VANHOY, Assistant Professor, and William D. KULP, Ensign, USN, "Teaching Undergraduate Physics With a Small Tandem Accelerator: Moseley's Law," American Association of Physics Teachers Summer Meeting, Vancouver, British Columbia, Canada, 24-29 June 1991.

KORMAN, Murray S., Associate Professor, and Charlene E. HUGHES, Midshipman 1/C, USN, "Experimental Investigation on the Amplification of Hydrodynamic Noise Generation by the Insertion of Air Bubbles in a Turbulent Flow," 123rd Meeting of the Acoustical Society of America, Salt Lake City, Utah, 11-15 May 1992.

KORMAN, Murray S., Associate Professor, and James E. PARKER, Midshipman 1/C, USN, "Exploration of Turbulence by Nonlinear Acoustic Scattering," 123rd Meeting of the Acoustical Society of America, Salt Lake City, Utah, 11-15 May 1992.

KORMAN, Murray S., Associate Professor, and James E. PARKER, Midshipman 1/C, USN, "Turbulent Energy Spectrum Predictions by Nonlinear Acoustic Scattering," 123rd Meeting of

the Acoustical Society of America, Salt Lake City, Utah, 11-15 May 1992.

KORMAN, Murray S., co-author, "Enhancement of Hydrodynamic Flow Noise Radiation by the Regulation of Air Bubbles in a Turbulent Water Jet," 123rd Meeting of the Acoustical Society of America, Salt Lake City, Utah, 11-15 May 1992.

MONTGOMERY, Steven R., Assistant Professor, and Michael D. MATSON, Midshipman 1/C, USN, "Holographic Interferometry on an Acoustic Guitar," The Eastern Colleges Science Conference, U.S. Naval Academy, Annapolis, Maryland, 4 April 1992.

MONTGOMERY, Steven R., Assistant Professor, and C. Andrew McCARTNEY, Midshipman 1/C, USN, "Picosecond Optical Mixing in Photorefractive Materials," The Eastern Colleges Science Conference, U.S. Naval Academy, Annapolis, Maryland, 4 April 1992.

SCHNEIDER, Carl S., Professor, "Magnetoelasticity for Large Stresses," Intermag 92, St Louis, Missouri, 13-16 April 1992.

SCHNEIDER, Carl S., Professor, "Anisotropy and Magnetoelasticity," Eleventh Annual Conference on Properties and Applications of Magnetic Materials," Chicago, Illinois, 12-14 May 1992.

TANKERSLEY, Lawrence L., Professor, co-author, "Imaging Through Scattering Media Using a Raman Amplifier," Optical Society of America Annual Meeting (OSA), Session MZ4, San Jose, California, 4-8 November 1991.

TANKERSLEY, Lawrence L., Professor, co-author, "Imaging and Interference in a Low Light Level Raman Amplifier," Optical Society of America Annual Meeting (OSA), Session FT4, San Jose, California, 4-8 November 1991.

TANKERSLEY, Lawrence L., Professor, co-author, "Quantum Limited Imaging in a Stimulated Raman Amplifier and Applications in Time-gated Imaging through Scattering Media," The International Society for Optical Engineering 1992 Symposium (SPIE OE LASE 92), Los Angeles, California, 19-24 January 1992.

VANHOY, Jeffrey R., Assistant Professor, co-author, "Search for Various Collective Excitation Modes with the  $(n,n')g$  Reaction," Third International Spring Seminar on Nuclear Physics: Understanding the Variety of Nuclear Excitations, Ischio, Italy, 21-25 May 1990.

VANHOY, Jeffrey R., Assistant Professor, co-author, "Doppler-Shift Lifetime Measurements with the  $(n,n')g$  Reaction and the Role of E1 Transitions from Octupole Excitations," European Research Conference on Nuclear Physics: Nuclear Shapes, Lake Balaton, Balatonfured, Hungary, 2-6 September 1991.

VANHOY, Jeffrey R., Assistant Professor, James R. HUDDLE, Associate Professor, Francis D. CORRELL, Professor, and William D. KULP, Ensign, USN, "Teaching Undergraduate Physics with a Small Tandem Accelerator," American Association of Physics Teachers Summer Meeting, Vancouver, British Columbia, Canada, 24-29 June 1991.

VANHOY, Jeffrey R., Assistant Professor, co-authors, "Relative Intensity of Single Escape, Double Escape, and Full-Energy Peaks for a 33% Efficient Intrinsic Ge Detector," Meeting of the Texas Section American Physics Society, Denton, Texas, 1-2 November 1991.

VANHOY, Jeffrey R., Assistant Professor, Gerhard S. SCHOENTHAL, Midshipman 1/C, USN, "127Xe Spectroscopy for Solar Neutrino Detection," Southeastern Section Meeting of the American Physical Society, Durham, North Carolina, 11-14 November 1991.

VANHOY, Jeffrey R., Assistant Professor, Midshipman 1/C Gerhard S. SCHOENTHAL, USN, "Low Spin States in 127Xe," 1992 Joint April Meeting of the American Physical Society and the American Association of Physics Teachers, Washington, DC, 20-24 April 1992.

VANHOY, Jeffrey R., Assistant Professor, "A User Perspective on the Stable Isotope," Nuclear Science Advisory Committee of the National Science Foundation and the Department of Energy, Washington, DC, 7 February 1992.

WINTERSGILL, Mary C., Associate Professor, and John J. FONTANELLA, Professor, "The Low Temperature Dielectric Behavior of Polymers and Copolymers of Tetrafluoroethylene," Twentieth North American Thermal Analysis Conference, Minneapolis, Minnesota, 22-25 September 1991.

WINTERSGILL, Mary C., Associate Professor, Joseph F. LOMAX, Assistant Professor (Chemistry), and John J. FONTANELLA, Professor, "High Valence Insertion Products of  $\beta$ -alumina: Preparation and Electrical Properties," Eighth International Conference on Solid State Ionics, Lake Louise, Canada, 20-26 October 1991.

## PHYSICS

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WINTERSGILL, Mary C., Associate Professor and  
John J. FONTANELLA, Professor, "Deuteron  
NMR Studies of NAFION Membrane Electrolytes

as a Function of Water Content," 1992 March  
Meeting of the American Physical Society,  
Indianapolis, Indiana, 16-20 March 1992.





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## Division of Professional Development





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## Leadership and Law

Commander Nicholas L. Flacco, USN  
Chair

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**M**embers of the Department of Leadership and Law continued to focus on research that has direct application to quality of life and education issues for the brigade of midshipmen. Research accomplished during the 1991-1992 academic year included: Dr. Karel Montor's evaluation of the order of merit and curriculum program; Dr. Paul Roush's extensive work involving the Myers-Briggs Type Indicator (MBTI) within a military application, as well as his studies of Academy graduate performance and the implications of midshipman time usage; and Dr. Ralph Juhnke's study of leadership effectiveness based on preconceived categories. Further, published works and presentations have examined and helped bring to light current leadership issues and concerns within the military, as well as provide a forum for critical and constructive review. These projects demonstrate a significant resource within the Naval Academy and are representative of the commitment all faculty members have in providing each midshipman a Total Quality Education.





## **Independent Research**

### **The Nature of Preconceived Categories on Leadership Effectiveness**

Researcher: Assistant Professor Ralph G. Juhnke

This research continues past efforts to identify psychological correlates of leadership perceptions by expanding the area of inquiry. The focus of this investigation concerns the nature of preconceived

categories of leadership and is designed to address current theoretical debates regarding the nature and structure of cognitive leadership categories.

### **Improving Academic Administration**

Researchers: Captain Sherman E. Wright, Jr., USN,  
and Professor Karel Montor

Evaluations of both the order of merit and curriculum programs at the Naval Academy were conducted with inputs from various members of the academic community. The results determined that academic viability could be obtained in U.S. Naval Academy programs while reducing the number of hours required for graduation. The order of merit analysis indicated the need, from a fairness and pre-

diction of future value to the Naval service standpoint, to modify percentages allocated to various midshipmen activities so that "credit" is provided for involvement in service-to-the-academy and a greater percentage to accomplishments in the area of physical education and JV-club-varsity athletics.

### **Faculty Handbook**

Researcher: Professor Karel Montor

The objective of this research is to determine the approaches used by leading educational institutions in the United States to the development of a faculty

handbook, administrative approaches to the academic promotion process, and the duties of a provost.

### **Leadership Instruction**

Researcher: Professor Karel Montor

Approaches to random access presentation of leadership vignettes were enhanced and procurement started to acquire equipment making

it possible to access randomly up to 72 minutes of leadership scenes from a 5-minute re-writable optical disc.

### Video Development for First Day of Leadership Instruction

Researcher: Professor Karel Montor

Because of the diversity of instructor backgrounds and their newness to the Academy teaching scene a video overview of the course was developed for

demonstrating, to instructors, the various video programs available to them for supplementing leadership instruction.

### Video Development for the Virginia Military Institute

Researcher: Professor Karel Montor

With Virginia Military Institute's adoption of the Naval Academy approach to teaching leadership, including using the same text, a cross section of

leadership scenes were produced that could be used to supplement classroom instruction.

### Applications of Psychological Preferences in the Military

Researcher: Associate Professor Paul E. Roush

This is a continuation of a research project begun in July 1987. The purpose of the research is to assess how knowledge of psychological preferences can be used in the military in the many manifestations of "know yourself, know your people, know your job." The primary research instrument is the Myers-Briggs Type Indicator (MBTI). The effort thus far has resulted in more than eleven thousand administrations of the instrument and development in conjunction with Computer Services of five computer programs for scoring the MBTI, accessing the data, and linking it to a wide range of variables. The study has included analysis of MBTI associations with leadership feedback, counseling feedback, transformational and transactional leadership, academic performance, voluntary attrition, time management, preference stability over time, service selection, leadership positions in the brigade, conduct grades, military performance grades, and accuracy of self-assessment. It has resulted to date in six presentations; three at regional conferences and one at an international conference of the Association for Psychological Type, one at the institutional research conference of the service academies, and one at the bi-annual

leadership conference of the Center for Creative Leadership. Two additional presentations are scheduled for the summer of 1992. Thus far, the project has resulted in the publication of articles in the *Journal of Psychological Type*, and *Military Psychology*. An article in an edited book, *The Impact of Leadership*, is currently in press. Leadership curricula and materials have been modified for the inclusion of MBTI theory and practice into two leadership courses taken by all midshipmen to sensitize them to the meaning and importance of individual differences. Midshipmen 3/C will take an expanded version of the MBTI, the Type Differentiation Indicator (TDI), and will receive the interpretation during the new 3/C leadership course, NL202: Developing Subordinates. During the current academic year presentations have been made locally to the faculties of three departments, English, Language Studies, and History, in order to acquaint those faculty members with the use of the MBTI to account for differing learning styles as a function of type differences. Local programming support for this project is provided by Julie Palmer in Computer Services.

### Enhanced Leadership Development

Researcher: Associate Professor Paul E. Roush

This project began in September 1987. Phase one of the research project involved development of NL301, a summer leadership course taken by all midshipmen. The course required each second classman to subject the plebe development program to a more rigorous and systematic scrutiny than has been the case prior to NL301. The course injected planning into that process and served as a rational counterpoise to the traditional approach of simply requiring new plebes to repeat upperclassmen's plebe experiences. In another aspect of NL301, class sessions were set aside for analysis by the midshipmen of very difficult problems facing the brigade. Midshipmen recommended solutions which, in turn, were screened, compiled, and forwarded for consideration by the Commandant.

Phase two of the project involved development of linkages between the classroom leadership work and the practical leadership experience in Bancroft Hall. Initially, that involved writing-projects which provided valuable feedback concerning the leadership experiences, from both the leaders' and the followers' perspectives. During academic year 1990-1991 the process was further expanded. The plebes used their personal computers to respond anonymously on three occasions to questions dealing with the leadership practices of the second classmen in their respective squads. On two occasions, after the upperclass had assessed themselves using the same criteria, the ratings supplied by the plebes were provided to the upperclass (in the form of aggregated data) as constructive feedback, during the second class lead-

leadership course in the spring semester. The feedback was the basis for significant changes in leadership behavior and in self-perception among many of the second classmen. This phase of the project yielded linkages between leadership feedback and the MBTI, and was the basis for two presentations in July 1991, one at the International Conference of the Association for Psychological Type and the second at the bi-annual research conference of the Center For Creative Leadership.

Phase three involved having the second classmen in one of the six battalions receive different ship instruction from that provided all the other battalions in the spring 1991 semester. The special instruction emphasized a particular counseling approach, and required significant documentation of the counseling process as part of the course work. The second classmen involved were rated by the plebes as making significantly greater improvement in positive leadership practices than were the second classmen in the other battalions. That counseling program was instituted brigade-wide beginning in the 1991-1992 academic year. The leadership feedback program provided objective evidence that the fourth class perceived upperclass leadership in 1991-1992 as being more positive in all thirty-two categories than was the case a year earlier. Local programming support for the Leadership Feedback project was originally provided by Lieutenant Blake Bush, USN, of the Professional Development Division, and is now under the auspices of Julie Palmer of Computer Services.

### Performance of USNA Graduates

Researcher: Associate Professor Paul E. Roush

This research program is accomplished in conjunction with the Naval Personnel Research and Development Center (NPRDC). During academic year 1990-1991 nearly two million fitness reports in the NPRDC database were analyzed at San Diego. The fitness reports encompassed a span of eighteen years (1972-1990) and all officer accession sources. The indicators of performance included continuation rates (a measure of willingness to remain on active duty), and rate of recommendation for early promotion. Outcomes to date include comparison of performance of Naval Academy graduates with that of officers from other accession sources, comparison among Academy graduates by gender

and by majority-minority status, and comparison of women graduates and minority graduates with women and minority officers from other accession sources. Marine Corps fitness-report data have been acquired from Headquarters, Marine Corps, and are currently undergoing analysis at NPRDC. Initial review of more than a million of these USMC fitness reports has now been concluded. Comparative results by accession source and by occupational specialty have been compiled for five indices on the fitness report. A separate breakout of results before and after 1980, the year the first women graduated from USNA, has also been compiled. Future directions in this independent

## LEADERSHIP AND LAW

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research include ascertaining the breakout of fitness report data by rank and separating out the data during the years 1966-1972 to assess potential differences during the Viet Nam conflict. In addition, the Graduate Performance Evaluation

System (GRAPES) questionnaire was substantially revised and piloted on a small sample in San Diego. The new version has been mailed to the fleet in an effort to obtain preliminary feedback for subsequent analysis and potential further revision.

### Use of Time by Midshipmen

Researcher: Associate Professor Paul E. Roush

This research project is an expansion of one begun in 1989 by Dr. Karel Montor of the Leadership and Law Department. The project involves stratified-random sampling of approximately a fourth of the brigade in the fall semester and again in the spring semester to survey time use by the members of the brigade. Midshipmen respond, using their personal computers, by distributing into 32 categories the 168 hours that constitute a week. The results are analyzed in order to assemble evidence regarding potential initiatives and to assess the effectiveness of

previous initiatives intended, for example, to put limits on certain activities and to maximize time available for study. Data are analyzed to ascertain time-use differentials by classes, by athletes versus non-athletes, by gender, Quality Point Ratio (QPR), major, service selection, and other variables. Local programming support for the Leadership Feedback project was originally provided by Lieutenant Blake Bush, USN, of the Professional Development Division, and is now under the auspices of Julie Palmer of Computer Services.

### Midshipmen Values Assessment

Researcher: Associate Professor Paul E. Roush

This research project involves having midshipmen respond on a survey about the values they hold. The survey began with the Class of 1995. It is done upon entry during the first week of plebe summer, upon completion of plebe summer, at the end of plebe year, midway through 3/C year, at the end of 2/C year, and prior to graduation during 1/C year.

The values survey was developed by the Institutional Research Office at West Point and has been in use there for more than a decade. Survey results will be compared with those at West Point to ascertain if changes follow the same pattern (are comparable in magnitude and direction) at both institutions.

## Publications

MONTOR, Karel, Professor, "We Need Leaders Not Technocrats," *Proceedings of U.S. Naval Institute*, (February 1990), 72.

The point is made that if the trend in decreasing numbers of Electrical Engineering majors and increases in Political Science students continues, we might have to go back to sail power.

MONTOR, Karel, Professor, "Challenges of the 1990's," *U.S. Naval Institute Membership News* (May 1990), 2.

A critical concern, for the future of the Navy, is the inflation of fitness reports which may make it difficult to separate front runners from those whose bosses write outstanding evaluations.

ROUSH, Paul E., Associate Professor, "Women Serving in Combat Would Strengthen America's Defense," C. Wekesser and M. Polesetsky, *Women in the Military*. San Diego: Greenhaven Press, 1991, pp. 59-63.

This article addresses and attempts to refute the assumptions underlying the combat exclusion laws. Those assumptions are (1) that women would denigrate the nation's ability to wage war, (2) society does not want them in units which may be subject to combat, and (3) the status quo, i.e., legislated exclusion, is working fine. Women's capabilities and the basis for establishing standards are examined. Fitness report data are used to

provide objective evidence of relative performance levels, by gender. The public response to women's performance in Operation Desert Storm is cited. Opportunity costs of perpetuating the status quo are catalogued in terms of the impact upon men, upon women, and upon the combat capability of the armed forces.

ROUSH, Paul E., Associate Professor, co-author, "Using the MBTI to Understand Transformational Leadership and Self-Perception Accuracy," *Military Psychology* 4, 1 (1992), 17-34.

Results of this study of student leaders at the Naval Academy indicated that the Myers-Briggs Type Indicator can be used to understand transformational and transactional leadership behaviors, as well as the leader's self-perception accuracy. Leaders who were evaluated as sensing and feeling types by the MBTI were the most transformational and used the most positive reinforcement with followers. Leaders who were introverts and sensing types had the most accurate self-perceptions. Additionally, transformational leader behaviors were related to reported extra effort on the part of followers. However, the most common type of leadership observed, active intervention with criticism when work was below standard, was unrelated to followers' extra effort. Results are discussed in terms of recommendations for leadership training and the usefulness of the MBTI in future leadership research.

## Presentations

ROUSH, Paul E., Associate Professor, "The Projected Effect on Unit Cohesion of Having Military Women in Combat Units," Testimony before the Presidential Commission on Women in the Military, Washington, DC, 9 June 1992.

ROUSH, Paul E., Associate Professor, "Enhancing the Role of Women in the Military," The Leaders' Forum (Forum Topic: Military Professionalism, with Emphasis on Accountability), U.S. Naval Academy, Annapolis, Maryland, 9 January 1992.

ROUSH, Paul E., Associate Professor, "The Myers-Briggs Type Indicator and Perceptions of Leadership Effectiveness," Leadership Research Conference of the Center for Creative Leadership (Conference Topic: The Impact of Leadership), Colorado Springs, Colorado, 29 July 1991.

ROUSH, Paul E., Associate Professor, "You Know You're a Good Leader, but Do Your Followers Agree?," Ninth International Conference of the Association for Psychological Type, Richmond, Virginia, 13 July 1991.



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